Before the
Federal Communications Commission
Washington, DC 20054

In the Matter of	)	
	)	
Promoting Interoperability in the 700 MHz Commercial Spectrum	)	WT Docket No. 12-69
	)	
Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band	)	RM-11592 (Terminated)

REPLY COMMENTS OF AT&T SERVICES INC.

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AT&T Services Inc. ("AT&T") submits the following reply comments in response to the Commission's March 21, 2012 Notice of Proposed Rulemaking.[1]

INTRODUCTION AND SUMMARY

Amid the controversy over Lower 700 MHz A Block licensees' misguided proposals to force AT&T to make network and handset changes that would degrade its LTE service, there is broad agreement on a fundamental proposition. Virtually everyone agrees that the public interest would be served by prompt Commission action to prevent high-powered Channel 51 and E Block broadcasts that are incompatible with efficient use of Lower 700 MHz spectrum. By addressing this root cause of the A Block licensees' concerns, the Commission would promote its interoperability goals in this proceeding without disrupting well-functioning standards-setting processes or spreading harmful interference to millions of additional consumers.

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[1] Notice of Proposed Rulemaking, *Promoting Interoperability in the 700 MHz Commercial Spectrum; Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band*, WT Docket No. 12-69 (Mar. 21, 2012) ("*Notice*").

Eliminating the sources of interference would spur LTE deployment in the A Block, where service is prohibited today in large exclusion zones around Channel 51 broadcast towers and further discouraged by the impending threat of debilitating, high-powered E Block transmissions. Equally important, it would create conditions that would encourage industry interoperability efforts that the *Notice* acknowledges are vastly preferable to an inflexible regulatory mandate. The comments contain a number of constructive suggestions for how the Commission could expeditiously clear Channel 51 and limit harm from E Block transmissions. AT&T stands ready to work with the Commission, the A Block licensees and other stakeholders to develop win-win interference solutions that will promote broadband investment, spectral efficiency, interoperability and, most importantly, the interests of broadband wireless customers.

By contrast, the comments make it clearer than ever that the proposed Band 12 mandate would harm consumers, reduce spectral efficiency, discourage investment, distort competition and do nothing to further any legitimate public policy objective. In particular, the comments strongly confirm that: (1) no regulation is needed to create a market for affordable, cutting edge Band 12 LTE devices or to provide A Block licensees with sufficient roaming options; (2) a Band 12 mandate would be extraordinarily costly, reducing LTE service quality and network capacity, requiring enormous mitigation investments that would likely be ineffective, and artificially tilting the competitive playing field by foisting those burdens on a single provider, AT&T, even as the mandate permanently damaged the standards-setting process; and (3) a "bait and switch" shift from the technology flexibility the Commission promised when it auctioned 700 MHz spectrum to a rigid, after-the-fact technology mandate would be patently unlawful.

First, the proposed regulation would be pointless. The A Block licensees' central claim – that they cannot obtain Band 12 devices without a mandate – has been resoundingly refuted in the marketplace. Although the first A Block LTE service was only recently launched, A Block licensees already have access to Band 12 handset, tablet, and hotspot variants of devices first produced for other LTE bands. Looking forward, A Block licensees are now working with manufacturers at the device *planning* stages to ensure that Band 12 versions are included in LTE product sets that will include a wide variety of configurations to reflect the rich diversity in LTE providers' spectrum holdings and technology choices.

The A Block licensees speculate that, absent a regulatory mandate, device manufacturers might not offer them the latest, greatest LTE devices or might not do so as soon or on reasonable terms. Recent developments have now refuted those claims as well. U.S. Cellular, the only provider currently operating in Band 12, just announced that it is offering a Band 12 version of Samsung's newest flagship LTE smartphone.[2] That handset, the Samsung Galaxy S III, is "widely considered this summer's blockbuster Android smartphone."[3] One prominent reviewer raves that it is "an amazing, amazing phone — the crème de la Android."[4] Another notes that it is already being called "the best Android smartphone on the market" and "could give Apple's

[2] Press Release, U.S. Cellular, *U.S. Cellular Customers Getting the Samsung Galaxy S III in July* (June 4, 2012), http://www.uscellular.com/about/press-room/2012/USCELLULAR-CUSTOMERS-GETTING-THE-SAMSUNG-GALAXY-S-III-IN-JULY.html ("'We're eager to get this iconic smartphone into the hands of our customers so they can experience the 4G LTE network on a powerful device with lots of new, unique and cool features.'").

[3] Michelle Maisto, *Enterprise Mobility: Samsung Galaxy S III: A First, Hands-On Look Before It's Everywhere*, eWeek.com (June 20, 2012), http://www.eweek.com/c/a/Mobile-and-Wireless/Samsung-Galaxy-S-III-A-First-HandsOn-Look-Before-Its-Everywhere-820015/?kc=EWKNLBOE06222012FEA1.

[4] David Pogue, *A Phone Bristling With Extras*, NYTimes.com (June 20, 2012), http://www.nytimes.com/2012/06/21/technology/personaltech/samsung-galaxy-s-iii-phone-bristles-with-extras-state-of-the-art.html?pagewanted=all ("[I]n Samsung's latest and greatest machine, you get 4G Internet speed, a huge screen and clever motion-sensing features — in a thin, stunningly sculptured slab. In the galaxy of app phones, this one is a bright, beautiful star.").

iPhone 4S a run for its money."[5] U.S. Cellular announced the Galaxy S III *at the same time and with the same retail price* as AT&T and Verizon.[6] Indeed, Samsung is debuting its flagship device with *five* different U.S. providers – each of which uses different LTE spectrum bands. Conjecture that A Block licensees lack the size or clout to obtain affordable, cutting edge LTE devices unless AT&T is forced to Band 12 is simply false.

The comments likewise confirm that A Block licensees would not be able to offer AT&T devices to their own customers even if the Commission did force AT&T to buy Band 12 devices. All AT&T handsets are designed to "fall back" to GSM/UMTS technology; the A Block licensees need handsets that employ CDMA technology. As one A Block licensee put it, a Band 12 mandate "makes no difference to people like us. ... If AT&T is forced to go from 17 to 12, they will still have GSM fallback, so that wouldn't open up the availability of handsets to anybody."[7] In other words, the proposed mandate would accomplish nothing. A Block licensees, like other LTE providers, would still need to work with manufacturers to obtain device variants tailored to their particular needs, and manufacturers would still base those devices not on the GSM/UMTS platforms they use for AT&T, but on the very different CDMA platforms they use for other providers.

Nor is there any roaming justification for a Band 12 mandate. The comments confirm that the multiband chipsets that are already the industry norm provide A Block carriers with

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[5] Hayley Tsukayama, *Samsung Galaxy S III: Review roundup*, Washington Post, May 29, 2012, *available at* http://www.washingtonpost.com/business/technology/samsung-galaxy-s-iii-review-roundup/2012/05/29/gJQABm8rzU_story.html.

[6] Lynn Walford, Wireless and Mobile News, *Samsung Galaxy S III (S3) Review of News/Release Date Roundup* (June 11, 2012), http://wirelessandmobilenews.com/2012/06/samsung-galaxy-iii-s3-review-news-2.html.

[7] Maisie Ramsay, Wireless Week, *LTE Interoperability: The Fix Regional Carriers Count On* (June 1, 2012), http://www.wirelessweek.com/Articles/2012/06/LTE-Interoperability-the-Fix-Regional-Carriers-Count-On/.

robust opportunities to roam on a variety of LTE (and other) networks in addition to other Band 12 networks. U.S. Cellular already uses quad-band LTE chipsets (and, indeed, was the first to offer that capability).[8] And LTE roaming options are about to expand further with chipsets that allow a device to transmit and receive signals on up to 3 different bands below 1 GHz and 7 bands in total.[9] In truth, A Block licensees' LTE roaming needs are no different than other LTE providers' needs – *all* providers, including AT&T, must rely upon multi-band chipsets to obtain ubiquitous LTE coverage – and the marketplace is already responding to those needs. Not only is a Band 12 mandate unnecessary, it would be flatly inconsistent with the Commission's finding just last year in its *Data Roaming Order* that it is manifestly *not* in the public interest to require any provider to alter its network to enable roaming.[10]

Second, although a Band 12 mandate would provide no public interest benefits, it would do great harm to competition and consumers. The proposed regulation would subject AT&T and its customers to interference that would degrade AT&T's LTE service quality and force AT&T to incur enormous and otherwise unnecessary costs in an effort to limit the harm from such interference. But that is only the tip of the iceberg. As Professor Katz and his colleagues Doctors Israel and Shampine explain in their reply declaration, it is well-established in economics, both theoretically and empirically, that entities will invest in reliance on standards at optimal levels only if they believe those standards are durable and not subject to after-the-fact reversal by regulators. Proponents of the Band 12 mandate do not even attempt to come to grips

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[8] U.S. Cellular, Anetsberger Decl. ¶¶ 6-7.

[9] Qualcomm at 61-62.

[10] Second Report and Order, *In the Matter of Reexamination of Roaming Obligations of CMRS Providers and Other Providers of Mobile Data Services*, 26 FCC Rcd. 5411, ¶ 43 (2011) ("*Data Roaming Order*") (finding it "reasonable for a provider not to offer a data roaming arrangement to a requesting provider that is not technologically compatible").

with the far-ranging negative consequences that would flow from a decision by this Commission to override a 3GPP standard years after it was adopted, particularly where, as here, the supposed justifications for such intervention so clearly lack merit.

The A Block licensees do continue to assert that forcing AT&T to Band 12 would not expose AT&T customers to harmful interference. But the record evidence overwhelmingly confirms that the interference-related harm is real and substantial. Rigorous testing and engineering analyses demonstrate that at typical real-world power levels, E Block and Channel 51 transmissions would cause substantially degraded service – creating broad LTE "no call" zones for AT&T's customers if AT&T were required to use Band 12 devices.[11]

There has never been any serious debate that E Block transmissions would cause debilitating interference, and the comments confirm that reality. A Band 17 filter provides "15,849 times" more attenuation of the high-powered E Block signal than the Band 12 filter can provide.[12] And, as Qualcomm demonstrates with the actual signal levels observed in its commercial MediaFLO service, AT&T Band 12 devices would, indeed, experience interfering signals strong enough severely to degrade LTE service quality under a typical E Block deployment of the type DISH has confirmed here that it plans to deploy.[13]

The record likewise overwhelmingly establishes that Channel 51 broadcasts would broadly and severely degrade Band 12 LTE service quality. Any doubt on this score should be put to rest by the controlled laboratory testing done by two different leading wireless certification firms – PCTEST Engineering Laboratory ("PCTEST") and 7Layers. This rigorous and independent testing of the impact of Channel 51 reverse intermodulation interference on the

[11] Qualcomm at 6-55.

[12] *Id.* at 9

[13] *Id.* at 13-18.

performance of commercially available Band 12 and Band 17 devices confirms that at Channel 51 signal levels likely to be experienced in the real world, Band 12 LTE service is severely degraded and, indeed, that the Band 12 device can *lose LTE connectivity altogether and cease even to see the LTE network*. In contrast, a Band 17 version of the same commercial device exposed to the same Channel 51 signal levels experienced no service quality degradation. And using Commission-approved propagation models and data, Qualcomm shows that the affected geographic areas around Channel 51 broadcast towers would be quite extensive in highly populated areas like Chicago, Kansas City and Providence: these affected areas account for about 70 percent or more of AT&T's data traffic in each those cities.[14]

The A Block licensees have relied upon a report by the engineering consulting firm Wireless Strategies. The report is riddled with methodological flaws and does not support the regulation proponents' assertion that Band 12 devices would perform as well as Band 17 devices for AT&T. Wireless Strategies concedes that E Block signals exceeding -56 dBm "may degrade ... performance, causing bit errors or interrupting communications" relative to 3GPP standards, and that signals will often be significantly higher than that in real-world E Block deployments.[15] And their evaluation of the impact of Channel 51 on Band 12 did not use Band 12 devices, assumed away the critical filter differences between Band 12 and Band 17, and is based entirely on Atlanta, where the Channel 51 transmitter is far outside of town and where all of the measurements were taken far from the tower at ground level where Channel 51 signal levels are likely lowest and cellular signal levels are likely to be highest.

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[14] Jeffrey H. Reed and Nishith D. Tripathi, *Supplemental Analysis: Impact of Channel 51 and E Block Interference On Band 12 and Band 17 User Equipment Receivers*, at 7 (July 16, 2012), attached hereto as Attachment A ("Reed-Tripathi Reply Report").

[15] Wireless Strategies at 20, 28.

The A Block licensees have now apparently jettisoned Wireless Strategies in favor of another consulting firm, V-COMM. But its report, submitted one business day before the due date for reply comments, fares no better. The highlight of the report, for example, is V-COMM's "testing on a live commercial network" in Waterloo, Iowa that US Cellular reconfigured to operate in the B and C Blocks on Band 12. V-COMM claims that its drive-testing of the reconfigured network is proof positive that Channel 51 poses no threat to Band 12 operation in the B and C Blocks. In truth, V-COMM's Waterloo "test" merely proves, once again, that if your goal is to find no harmful interference, all you have to do is look in the wrong places. The nearest Channel 51 broadcast tower to Waterloo is in Cedar Rapids, *nearly 60 miles away*. No wonder then that V-COMM's own modeling shows that the Channel 51 signal levels in and around Waterloo are well below the thresholds that Qualcomm, PCTEST, and 7Layers have shown would trigger performance-degrading interference. V-COMM points out that a small segment of its extensive Waterloo drive test route veered into the Cedar Rapids Consolidated Metropolitan Area ("CMA"), but US Cellular does not control the C Block in the Cedar Rapids CMA and thus even at high Channel 51 signal levels its operations there could not create reverse intermodulation interference in the Band 12 devices.

V-COMM's conclusory Channel 51 and E Block lab test results are equally undeserving of serious consideration. Among other failings, V-COMM, tellingly, fails even to disclose the LTE signal levels it used to obtain results that are so irreconcilable with all of the other testing and analyses in the record.

There is no solution – absent eliminating the interfering sources – that could avoid these interference harms. As AT&T demonstrated in its Opening Comments, attempts to build around the problems with additional base stations collocated with or near the interfering sources would be staggeringly expensive and largely ineffective. Qualcomm provides further support and explanation why the addition or relocation of LTE base stations is not a viable strategy for addressing Channel 51 or E Block interference, because of the high power and very different coverage patterns of such transmitters and because, as its lab test results confirm, LTE devices are vulnerable to interference from Channel 51 broadcasts throughout affected cells, and not merely at cell edges. Nor do proponents of a Band 12 mandate take seriously the reality that any attempt to implement a Band 12 mandate without stranding existing Band 17 LTE customers would take years. Vulcan speculates that AT&T could move immediately to Band 12 merely by transmitting over-the-air "updates" to the Band 17 devices of its millions of existing LTE customers to "convert" them to Band 12, but as Mr. Prise and Mr. Howard explain in their reply declaration, this is a pie-in-the-sky fantasy.

Third, and finally, a Band 12 mandate would be an unlawful retroactive modification of AT&T's licenses. The mandate's proponents make little effort to provide a basis for such a retroactive modification beyond the general licensing provisions that courts have previously held are not delegations of authority to adopt specific regulations. Moreover, as a former Wireless Bureau Chief recently noted, the Band 12 mandate "shares the characteristics of the individual [health care] mandate that the [Supreme] Court considered constitutionally objectionable": the Commission "has proposed forcing AT&T … to buy equipment that operates on the 700 MHz A Block spectrum, which AT&T cannot legally use, in order to subsidize the costs of AT&T competitors, who are licensed to use that spectrum."[16]

By contrast, and contrary to DISH Network's contentions, the Commission has ample authority to adopt measures addressing the potential interference from E Block transmissions.

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[16] Communications Daily, July 9, 2012, at 8-9 (quoting Fred Campbell, Director of the Competitive Enterprise Institute's Communications Liberty and Innovation Project).

Section 303(f) of the Communications Act gives the Commission express authority to modify licenses to prevent interference from harming adjacent users.

In short, the proposed mandate would do nothing to alleviate the sources of interference that are impeding deployment of LTE on Lower 700 MHz A Block spectrum. Rather, the mandate would only spread that interference to AT&T's LTE services, degrading the quality and value of AT&T's services and increasing AT&T's costs. That might serve the interests of Verizon, Sprint, T-Mobile and AT&T's other competitors, diminishing their need to improve the prices and quality of their own services, but it quite plainly would harm consumers and the public interest.

ARGUMENT

I. REGULATORY PROPONENTS FAIL TO DEMONSTRATE THAT A BAND 12 MANDATE WOULD PROVIDE ANY BENEFITS.

The comments confirm beyond doubt that the two purported justifications for the Band 12 mandate – that it is necessary for A Block licensees to obtain quality LTE devices and to roam with other carriers – are baseless.

A. AT&T's Operation In Band 17 Does Not Prevent A Block Licensees From Obtaining High Quality LTE Handsets, And Forcing AT&T To Band 12 Would Not Add To A Block Licensees' Device Choices.

The A Block licensees' central contention in this proceeding – that they do not have the scale or ability to obtain LTE devices without a Band 12 mandate on AT&T – has been conclusively disproved.[17] High quality Band 12 LTE devices are readily available.[18] Indeed, shortly after the opening comments were filed, U.S. Cellular announced that it will be offering

[17] *See* Report of Mark A. Israel, Michael L. Katz, and Allan L. Shampine, ¶¶ 36-43, attached hereto as Attachment B ("Israel-Katz-Shampine Reply Decl.") (reviewing marketplace evidence).

[18] AT&T at 11.

the brand new Samsung Galaxy S III – "[t]he new flagship smartphone from the world's number-one mobile phone company"[19] – at the same time as AT&T, Verizon, and a number of other providers. This device is among the most advanced LTE devices yet released, with U.S. Cellular touting it as "iconic," and "cutting-edge."[20] Analysts agree, describing the device as "an amazing, amazing phone – the crème de la Android."[21]

U.S. Cellular's success in obtaining "cutting edge" LTE devices is not unique. Notwithstanding its supposed "diseconomies of scale" and being the *first* LTE provider, Metro PCS has been able to obtain a variety of LTE handsets from multiple manufacturers and to offer them at highly competitive prices even without long term contracts.[22] C Spire (Cellular South) has already announced that it, too, will soon be offering the Galaxy S III, and its LTE service has not yet even launched.[23] Equally significant, C Spire was able to obtain an AWS version of the Galaxy S III, even though LTE is not yet widely deployed in that spectrum band.

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[19] Sascha Segan, Samsung Galaxy S III (Sprint), PC Magazine (June 20, 2012), *available at* http://www.pcmag.com/article2/0,2817,2406037,00.asp.

[20] Dan Graziano, BGR.com, *Samsung Galaxy S III Coming to U.S. Cellular in July* (June 5, 2012), http://www.bgr.com/2012/06/05/samsung-galaxy-s-iii-launch-u-s-cellular-preorders-june-12/.

[21] *See, e.g.*, Walford, *supra* n. 6 (device "will be the premier smartphone this summer" and analysts are "predict[ing] … that it may beat out the iPhone …."); Joanna Stern, ABC News, *Samsung Galaxy S III Review: The New Android Phone to Beat* (June 20, 2012), http://abcnews.go.com/Technology/samsung-galaxy-android-smartphone-review/story?id=16607381#.T-NKarXY_gc (describing the phone as "packed to the brim with cutting-edge mobile technology and new features, making it . . . the Android phone to beat this year.").

[22] *See* MetroPCS Store, http://www.metropcs.com/metro/category/Phones/4G+LTE/cat170022 (last visited July 12, 2012); MetroPCS, *2011 Annual Report*, 5, http://investor.metropcs.com/phoenix.zhtml?c=177745&p=irol-reportsAnnual.

[23] C Spire Wireless News, *Samsung Galaxy S III Coming Soon on Nation's First Personalized Network* (June 12, 2012), http://www.cspire.com/company_info/about/news_detail.jsp?entryId=14200004.

The reason why even small carriers can obtain state-of-the art LTE devices is simple. As AT&T previously explained, device manufacturers do not design devices for each spectrum band from scratch. To the contrary, if a wireless provider works with the manufacturer during the planning stages, the manufacturer can make a Band 12 variant of an LTE device that will also be distributed in different band configurations by other providers – at little or no incremental cost. Indeed, manufacturers quite rationally build new LTE devices to accommodate the wide variety of LTE band configurations demanded by providers with different spectrum holdings, networks and business strategies. Modular device platforms can be outfitted with the filters, radios and software needed to accommodate Band 12, just as they can be outfitted with filters, radios and software needed to accommodate numerous other LTE bands – changes that A Block licensees themselves have conceded have virtually "no cost impact."[24]

And that is precisely what is now happening: once U.S. Cellular was far enough along in its LTE deployment to justify working with Samsung during the planning stages, it was able to obtain a Band 12 version of the Samsung Galaxy S III on the same time frame as other, larger providers. And U.S. Cellular is obviously obtaining the device at an affordable cost that allows it to offer the device at a price comparable to that of AT&T, Sprint, T-Mobile and Verizon.[25] These marketplace facts foreclose the A Block licensees' claims that they do not have sufficient economies of scale to obtain such devices; to the contrary, device manufacturers have strong

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[24] Letter from Michele C. Farquhar (Vulcan) to Marlene H. Dortch (FCC), WT Docket Nos. 06-150, 11-18, RM-11592 (Dec. 5, 2011), Attachment at 22.

[25] Walford, *supra* n. 6.

incentives to make devices for any carrier that will promote them, regardless of its size – as the rapidly developing Band 12 device portfolio starkly illustrates.[26]

U.S. Cellular complains that it took two years of discussions with many handset manufacturers to obtain a handful of LTE devices from a single manufacturer for its network launch.[27] But U.S. Cellular is simply describing what all carriers, including AT&T, face when deploying a new technology. AT&T began providing manufacturers with detailed technical information regarding its requirements for LTE devices in 2008, but did not offer any smartphone devices until the end of 2011.[28] Further, AT&T launched its initial LTE services with data-only devices,[29] and did not have a LTE smartphone until a few months later.[30] U.S. Cellular was able to offer a smartphone within a couple of weeks of launching its LTE service.[31] These facts illustrate once again that the A Block licensees can and do take advantage of the device development work initially funded by AT&T and Verizon.[32] And, as noted, U.S. Cellular obtained smartphones with Qualcomm's quadband chipset *before* AT&T.[33]

U.S. Cellular further complains that it initiated discussions with many manufacturers but ended up offering devices from only one,[34] but that too is normal. AT&T sent its LTE device

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[26] *Cf.* King Street Wireless at 7. A smaller carrier that is willing to more heavily promote a new device may prove a better partner than a much larger carrier with an established portfolio of comparable devices.

[27] U.S. Cellular, Anetsberger Decl. ¶¶ 2, 11-12.

[28] Reply Declaration of Michael Prise and Jeffrey Howard, ¶ 15, attached hereto as Attachment C (Prise-Howard Reply Decl.").

[29] *Id.* ¶¶ 15, 17.

[30] *Id*.

[31] U.S. Cellular, Anetsberger Decl. ¶ 11.

[32] Prise-Howard Reply Decl. ¶ 14.

[33] *Id.* ¶ 11.

[34] U.S. Cellular, Anetsberger Decl. ¶¶ 4-9.

specifications to over ten manufacturers, but ultimately ended up having devices from only two manufacturers when it launched service.[35] Since then, AT&T has increased the number of manufacturers from whom it offers LTE devices, and there is likewise no reason that U.S. Cellular will not be able to expand its stable of manufacturers.[36]

In all events, Band 12 AT&T devices would be of little, if any, value to A Block carriers because AT&T uses GSM/UMTS technology in its phones when LTE service is unavailable, whereas the A Block carriers rely on CDMA technology.[37] Some A Block licensees have candidly acknowledged this point. For example, United Wireless points out that a Band 12 mandate "makes no difference to people like us. … If AT&T is forced to go from 17 to 12, they will still have GSM/UMTS fallback, so that wouldn't open up the availability of handsets to anybody."[38]

No Block A licensee has even attempted to address this controlling marketplace reality, leaving it to their trade association to try to mount a rebuttal. But RCA's position ultimately amounts to nothing more than an *ipse dixit* assertion that it is easy to adapt GSM/UMTS fall back phones into CDMA-fall back phones.[39] RCA offers no intelligible justification for this

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[35] Prise-Howard Reply Decl. ¶ 16.

[36] *Id.* ¶¶ 18. C Spire has asserted that its decision to offer LTE service initially over AWS spectrum rather than its A Block spectrum was driven by an inability to obtain Band 12 devices. But given that C Spire has already announced that it will distribute the new Samsung LTE "flagship" smartphone that is already available with Band 12 capabilities, it is simply not credible to suggest that lack of equipment is what is driving C Spire's decision. It is also notable that the fact that C Spire is deploying base stations without Band 12 signaling does not mean that C Spire will be unable to add Band 12 in the future, as C Spire's network equipment vendor has confirmed. *See* Maisie Ramsay, Wireless Week, *C Spire Leaving 700 MHz Out of LTE Gear, ALU Says* (June 5, 2012), http://www.wirelessweek.com/News/2012/07/c-spire-leaving-700-mhz-out-of-LTE-gear/.

[37] AT&T at 14; Prise-Howard Reply Decl. ¶¶ 19-21.

[38] Ramsay, *supra* n. 7.

[39] *See id.* (statement of RCA President Steven Berry).

assertion, and, as Mr. Prise previously explained, there are substantial device architecture differences that go well beyond the use of different radios and filters.[40] Making an A Block licensee-compatible variant of an AT&T Band 12 device would require replacing the GSM/UMTS radios with CDMA radios and redesigning the circuitry and radio architecture for simultaneous dual radio operations.[41] That is a vastly more complicated and expensive design modification than simply changing the filter and radio from one LTE band class to another. Accordingly, even if the Commission ordered AT&T to implement an expensive and disruptive network-wide change to support Band 12 phones, A Block licensees, like all other LTE providers, would still need to work with manufacturers to obtain device variants tailored to their particular needs, and manufacturers would still base those devices not on the GSM/UMTS platforms they use for AT&T devices, but on the very different CDMA platforms they use, for example, for Verizon Band 13 LTE phones.[42]

At the end of the day, the A Block licensees' "scale" claims boil down to the proposition that it is "unfair" that larger carriers may be able to purchase handsets at a lower per-unit cost because of purchasing economies.[43] But the Commission has recognized that such scale

[40] Prise Decl. ¶¶ 21-24.

[41] *Id.*; Prise-Howard Reply Decl. ¶¶ 20-25.

[42] Of course, even if RCA were correct that such a significant redesign of an AT&T phone could be considered trivial, that would only serve to prove there is no need for a Band 12 mandate in the first place. Prise-Howard Reply Decl. ¶ 22. To the extent that redesigning an AT&T GSM-based phone is a modest undertaking, as RCA suggests, *a fortiori* making variants of LTE phones used by other CDMA-based providers, or for that matter, variants of AT&T's Band 17 phones, can be easily undertaken. *Id.*

[43] *See, e.g.*, Cavalier at 6-7 (interoperability justified on grounds that smaller carriers pay more for phones); Cricket at 7 (interoperability will lead to lower prices for phones for A Block carriers; smaller carriers disadvantage by "higher prices" they pay); King Street Wireless at 9 (smaller carriers have to pay more for phones); MetroPCS at 8-9 ("Without interoperability, A Block licensees lose on the economies of scale that are essential to them to be on par with the nation's largest carriers both technologically and with respect to equipment price."); NTCA at 6

economies in purchasing are legitimate efficiencies and not a basis for imposing regulation.[44] In any event, a Band 12 mandate would not have any effect on the scale of AT&T's purchases and would do nothing to address any alleged "disparity" in purchasing economies between AT&T and A Block licensees.

B. A Band 12 Mandate Is Not Necessary For A Block Licensees To Obtain Roaming.

Unable to show that a Band 12 mandate is necessary to obtain high quality LTE devices, the A Block licensees shift to the contention that a Band 12 mandate is necessary to ensure that they will have the ability to roam with other carriers.[45] The comments confirm, however, that these claims also have no basis in fact – A Block licensees already have the ability to roam and options going forward are only increasing.

Numerous bands are currently being (or soon will be) used to provide LTE service in addition to Bands 12 and 17, including 4 (AWS), 2 (Cellular), 5 (PCS) and 13 (Upper 700

(smaller carriers have to pay "substantially higher prices than what the large carriers offer"); *see also* Vulcan at 22. Notably, the A Block licensees offer nothing to prove this point and the fact that U.S. Cellular was able to obtain the Samsung Galaxy III at a cost that enables it to offer the phone at the same price as "larger" carriers casts significant doubt on any argument that A Block licensees will be at a disabling competitive cost disadvantage because of their smaller size.

[44] The Commission and the courts have held repeatedly that the "Commission's statutory responsibility is to protect competition, not competitors." Order and Authorization, *In re Application of Alascom, Inc. AT&T Corporation and Pacific Telecom, Inc. For Transfer of Control of ALC, Inc. from Pac. Telecom, Inc. to AT&T Corp.*, 11 FCC Rcd. 732, ¶ 56 (1995); *SBC* v. *FCC*, 56 F.3d 1484 (D.C. Cir. 1995) ("[t]he Commission is not at liberty . . . to subordinate the public interest to the interest of equalizing competition among competitors"). In this regard, the Commission has squarely held that firms may have many advantages, including "perhaps, resource advantages, scale economies, established relationships with suppliers, ready access to capital, etc.," but the mere fact that a firm has these advantages does not mean that it is "appropriate for government regulators to deny the incumbent the efficiencies its size confers in order to make it easier for others to compete." Report and Order, *Competition in the Interstate Interexchange Marketplace*, 6 FCC Rcd. 5880, ¶ 60 (1991).

[45] Blooston Rural Carriers at 7; Cavalier Wireless at 7; Cellular South at 4; Consumers Union at 9-10; Cricket at 8; Horry at 5; MetroPCS at 5; NTCA at 7; NTCH at 2; RCA at 14; RTG at 9-10; T-Mobile at 7-10; U.S. Cellular at 14-15; Vulcan at 25-27.

MHz).[46] In this environment, multi-band chipsets are a necessity, and manufacturers are meeting that demand. Today Qualcomm offers chipsets capable of providing service in five different bands.[47] To be sure, there are limits on the number of ports that can be allocated to spectrum below and above 1 GHz (two and three, respectively), but LTE is being deployed in a wide variety of bands both below and above 1 GHz.[48] Just as AT&T offers LTE devices today that support both Band 17 and Band 4, and will soon, like U.S. Cellular, offer "quad band" devices that support Band 2 and Band 5 as well, A Block licensees have the ability today to obtain multi-band LTE devices.[49]

Thus, the A Block licensees already have many roaming options, and the comments confirm that those options are about to increase significantly without an interoperability mandate, as at least some regulation proponents concede.[50] As Qualcomm notes, it has developed a new chipset that will begin shipping shortly that will allow a device to transmit and receive signals on up to 3 different bands below 1 GHz (and 7 bands in total).[51] Thus, A Block carriers will be able to obtain devices that can roam on AT&T's Band 17 network even without a Band 12 mandate, as well as have several options for roaming in bands above 1 GHz.[52] Notably,

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[46] Prise Decl. ¶¶ 26-27; Israel-Katz-Shampine Reply Decl. ¶¶ 45, 48.

[47] Qualcomm at 59.

[48] Prise Decl. ¶ 26; Prise-Howard Reply Decl. ¶ 24; Israel-Katz-Shampine Reply Decl. ¶¶ 48-50.

[49] Prise-Howard Reply Decl. ¶ 26.

[50] T-Mobile at 9.

[51] Qualcomm at 61-62.

[52] In this regard, MetroPCS is currently providing LTE service over AWS, C Spire has announced plans to do so in the fall, and AT&T, T-Mobile and Verizon will also offer LTE over AWS. *See* Sam Churchill, dailywireless.org, *MetroPCS Moves to Voice Over* LTE (Aug. 3, 2011), http://www.dailywireless.org/2011/08/03/metropcs-moves-to-voice-over-lte/; Evdoinfo.com, *C Spire LTE Coming September 2012*, http://www.evdoinfo.com/content/view/4178/64/ (last visited July 12, 2012). Thus, A Block

the A Block licensees are only at the beginning stages of deploying their LTE networks, and therefore they have significant flexibility to choose the bands on which they want to roam and have their phones designed accordingly.[53] And, of course, A Block licensees can always roam on the networks of other A Block licensees.[54]

More fundamentally, it is unlikely that AT&T would be a preferred roaming partner for the A Block licensees for reasons independent of the issues raised in this proceeding. Currently, voice-over-LTE service generally is not supported; rather, to provide voice service to its LTE customers, a wireless provider must rely on its "fall back" to a non-LTE network.[55] But, as explained above, AT&T uses GSM/UMTS for its fall back network while the A Block carriers are mostly CDMA-based. This may make AT&T a relatively unattractive roaming partner for an A Block carrier, because that carrier would presumably still need a separate roaming agreement with another CDMA carrier – both to cover voice service for its roaming customers and for both voice and data coverage where AT&T does not provide LTE service – and make the necessary technical adjustments that would allow a customer to obtain LTE data services from AT&T but voice services from another CDMA carrier in the same service area.[56] To be sure, the advent of voice-over-LTE may make it easier for CDMA-based carriers to roam on a GSM/UMTS-based carrier like AT&T, but by that time multi-band chipsets will ensure that A Block carriers have many other roaming options.

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licensees that deploy Band 12 LTE networks could choose multi-band devices that also include an AWS port, enabling them to roam on many other carriers' AWS LTE networks.

[53] Prise-Howard Reply Decl. ¶ 24.

[54] *Id.;* Israel-Katz-Shampine Reply Decl. ¶ 51.

[55] Prise-Howard Reply Decl. ¶ 16, 19; Israel-Katz-Shampine Reply Decl. ¶ 51.

[56] Israel-Katz-Shampine Reply Decl. ¶ 51.

Beyond that, AT&T does not have nationwide coverage with Blocks B and C and will rely to a substantial degree on other bands to fill in its network.[57] Roaming on other bands with other carriers may thus be more attractive to the A Block carriers – particularly, as noted, if the other carrier can provide fall-back CDMA service that AT&T cannot.[58] At most, AT&T's Lower 700 MHz spectrum is just one of many bands being used to provide LTE; it is far from "essential" to network coverage.

In all events, in the *Data Roaming Order*, the Commission expressly held that mobile broadband providers should not have to modify their networks merely to accommodate a request for data roaming. Thus, the Commission's data roaming rules expressly recognize that it is "reasonable for a provider not to offer a data roaming arrangement to a requesting provider that is not technologically compatible."[59] These limitations are consistent with a broad line of precedent establishing that even common carriers generally do not have to modify their networks to accommodate requests from competitors for network access.[60] The mandate proposed here – in which AT&T would be required to modify its entire nationwide LTE network, change its business plans, and manage a mid-stream transition to a different band class, merely to provide A Block licensees *one additional roaming option* that it is doubtful that they would elect to use – would be an egregious departure from this precedent that would be patently arbitrary and capricious.

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[57] *See* Prise Decl. ¶ 26 (noting that AT&T will be providing LTE services using Bands 2, 4 and 5 in addition to Band 17).

[58] Israel-Katz-Shampine Reply Decl. ¶¶ 46, 50-51.

[59] *Data Roaming Order* ¶ 43.

[60] *U.S. Telecom Ass'n* v. *FCC*, 359 F.3d 554, 577-78 (D.C. Cir. 2004) (incumbent local telephone carriers need not go beyond "routine network modifications" that they "regularly undertake for their own customers" when providing competitors leased access to network facilities); *Iowa Utils. Bd.* v. *FCC*, 120 F.3d 753, 812-13 (8th Cir. 1997).

II. THE RECORD EVIDENCE OVERWHELMINGLY DEMONSTRATES THAT THE PROPOSED BAND 12 MANDATE WOULD INFLICT SUBSTANTIAL INTERFERENCE-RELATED HARMS ON AT&T AND ITS CUSTOMERS, UNDERMINE WIRELESS INNOVATION AND COMPETITION, AND THREATEN TO STRAND CONSUMER DEVICES.

Although there was never any serious dispute that the proposed Band 12 mandate would inflict substantial interference-related harms on millions of B and C Block LTE customers, the record evidence should silence any remaining doubters on that score. All sectors of the industry – and most notably, chipset and device manufacturers – both confirm and quantify the increased interference and resulting service quality harms that such customers would experience from the high-powered Channel 51 and E Block transmissions that are immediately adjacent to Band 12. Indeed, the comments convincingly demonstrate that, if anything, the likely harms are significantly greater than what most neutral parties have always assumed.

The record now contains *multiple* empirical studies documenting that, both individually and collectively, Channel 51 and E Block interference would create substantial "no call" zones for AT&T customers if AT&T is forced to Band 12. Qualcomm confirms that Band 12 devices would suffer quality-impacting levels of interference from both Channel 51 and E Block transmissions, and testing of actual Band 12 and Band 17 devices conducted by PCTEST and 7Layers establishes that B and C Block customers using Band 12 devices would experience slower or dropped connections at Channel 51 signal levels even weaker than Qualcomm's engineering analyses predict. And, using well-accepted and Commission-approved tools, Qualcomm shows that Channel 51 and E block signal levels high enough to cause harmful interference exist throughout large geographic areas, including urban areas where mobile broadband usage is most intensive.[61] While either one of these sources of interference would

[61] Qualcomm at 54-55.

cause widespread degradation of service, the cumulative effect of the two sources of interference would be devastating. Attempting to combat this interference with an expensive campaign of adding cell sites is likely to be ineffective because, as the engineering evidence shows, the harms from harmful interference can occur anywhere within an affected cell – not just at the cell edge, as has been typically assumed. At a minimum, subjecting AT&T to increased interference will increase the incremental costs of network expansion and reduce AT&T's incentives and ability to expand its LTE footprint as well as upgrade capacity within AT&T's existing footprint.[62]

Simply put, "[t]he mandate would harm wireless telecommunications services consumers by distorting competition."[63] The mandate would not solve any of the interference issues that impact deployment of LTE services on A Block spectrum. Instead, the mandate would "share the pain" by spreading that interference to AT&T despite AT&T having invested heavily in the first instance to avoid Channel 51 and E Block interference. Thus, the mandate will serve only to degrade the quality of AT&T's LTE service, harming customers and forcing AT&T to waste enormous sums of money trying to mitigate interference. Although this would benefit AT&T's rivals by reducing the competitive pressures they face from AT&T's high quality wireless offerings, consumers – indeed, all consumers – would face higher prices and lower quality service as a result of this reduction in competition.[64] On a longer term basis, the damage that would result from politicizing industry standards setting processes that are indispensable to

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[62] Israel-Katz-Shampine Reply Decl. ¶¶ 21-22.

[63] *Id.* ¶ 9.

[64] *Id.* ¶¶ 9, 12, 17.

investment and innovation, particularly at this juncture and with so little basis for doing so, would be incalculable.[65]

A. The Mandate Will Have Far-Ranging, Negative Consequences On Wireless Investment And Innovation.

Proponents of the Band 12 mandate are either shockingly naïve or remarkably indifferent about the enormous lasting harm their proposals would cause. Either way, they scrupulously ignore the fundamental, far-ranging harms that would flow from any Commission attempt to interfere with the independence of the international standards-setting regime.

Independent standards based on internationally-vetted engineering judgments are a critical foundation for competition, innovation, and investment.[66] As the Department of Justice and Federal Trade Commission have emphasized, "[i]ndustry standards are widely acknowledged to be one of the engines driving the modern economy" because such standards "can make products less costly for firms to produce and more valuable to consumers" and "make networks … more valuable by allowing products to interoperate."[67] The Commission's Technical Advisory Board for First Responder Interoperability has reached the same conclusion, recently emphasizing that the "open, consensus-based" approach that the industry uses to develop and maintain technology standards is a "critical factor" that is "responsible" for the "high level of interoperability" achieved on commercial networks.[68]

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[65] *Id.* ¶ 9, 24-30.

[66] CLIP at 6; CEA at 7-8.

[67] Fed. Trade Comm'n, Dep't of Justice, *Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition* 33 (2007), *available at* http://www.ftc.gov/reports/innovation/P040101PromotingInnovationandCompetitionrpt0704.pdf.

[68] Technical Advisory Board for First Responder Interoperability, *Recommended Minimum Technical Requirements to Ensure Nationwide Interoperability for the Nationwide Public Safety Broadband Network*, § 3.1 (May 22, 2012)), *available at* http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0621/FCC-12-68A3.pdf ("The

This is particularly true in an area as complex as broadband wireless networks where multiple layers of equipment and devices need to communicate. 3GPP standards "provide the 'ground rules' from which the wide range of industry participants within the wireless ecosystem can work, and the confidence that the equipment, devices, and software they develop will be compatible with mobile broadband networks based on those same standards."[69] But, as the economic literature makes clear, these standards will only serve their intended function if they are viewed as durable by industry participants.[70] Economic studies confirm the commonsense notion that a company will have substantially reduced incentives to invest in reliance on a standard that it believes is subject to after-the-fact regulatory revisions that might strand its investment.[71]

For these reasons, the Commission's flexible use policies have long protected the independence of the standards-setting process and have allowed licensees to choose the networks and devices that best meet their customers' needs. The Commission built that flexibility into its regulatory structure governing the Lower 700 MHz band from the beginning, determining that "a flexible, market-based approach is the most appropriate method for determining service rules in

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high level of interoperability achieved on commercial service provider networks did not happen by accident. One critical factor responsible for the high level of interoperability achieved on commercial service provider networks is the process used by the commercial market to develop and maintain technology standards. The open, consensus-based process adopted by 3GPP, for example, creates a forum which encourages both technological innovation and the maintenance of backward compatibility. This approach has allowed service providers to offer new services while protecting the significant investments they have made in the construction and operations of their networks. The use of rigorously defined architectures and interfaces in LTE promotes interoperability by giving service providers stable interfaces around which to design their networks. Furthermore, this practice promotes competition, drives innovation and lowers costs among vendors of equipment, user devices, software and services.").

[69] AT&T Comments, Wolter Decl. ¶ 8.

[70] Israel-Katz-Shampine Reply Decl. ¶¶ 27.

[71] *Id.* ¶ 27.

this band."[72] Under that approach, licensees were given broad latitude to "make determinations respecting the services provided and the technologies used."[73] The Commission recognized that "marketplace forces operating through the auction process, rather than regulatory fiat, will determine which of the multitude of service proposals will actually be implemented."[74] Indeed, prior to this proceeding, licensees and equipment manufacturers around the world would have scoffed at the notion that the Commission might insert itself into the standards-setting process and force carriers to ceasing using standards that had already been established by 3GPP and implemented in the marketplace.

Abandoning these long-established principles, and compromising the independence and predictability of the standards-setting process, will cause several substantial harms with lasting consequences beyond this proceeding.[75] The most obvious types of harm, of course, are the immediate ones – *i.e.*, ignoring and overriding 3GPP's considered engineering judgment with respect to the potential for interference could cause severe consumer harms. The choice of a proper standard involves complex engineering judgments. When interference concerns are at issue, the choice of a standard will require "predictive judgments regarding future deployment scenarios" as well as engineering judgments "regarding the appropriate level of interference

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[72] First Report and Order, *In the Matter of Service Rules for the 764-764 and 776-794 MHz Bands*, First Report and Order, 15 FCC Rcd. 476, ¶¶ 1-2, 15, 18, 31 (2000) ("*Upper 700 MHz Order*"); *see also* Second Report and Order, *In the Matter of Service Rules for the 698-746, 747-762 and 777-792 MHz Band*, 22 FCC Rcd. 15289, ¶ 94 (2007) ("*Second Lower 700 MHz Order*"); Report and Order*, In the Matter of Reallocation and Service Rules for the 698-746 MHz Spectrum Band (Television Channels 52-59)*, 17 FCC Rcd. 1022, ¶¶ 1, 13-15, 124-125 (2002) ("*First Lower 700 MHz Order*"). The Commission's service rules for the Lower 700 MHz Band were based on the framework it established for the Upper 700 MHz Band. Compare *id.* ¶¶ 5, 125.

[73] Upper 700MHz Order ¶¶ 15, 18.

[74] *Id.* ¶ 31.

[75] Israel-Katz-Shampine Reply Decl. ¶¶ 20-34.

protection."[76] Such judgments are best left to engineering-based standard setting organizations like 3GPP and the market participants.[77] If the Commission orders the industry to adhere to a different standard *notwithstanding* 3GPP's judgment that such a standard could lead to unacceptable levels of interference, the potential negative consequences are enormous if the Commission has guessed wrong.[78]

Moreover, *any* Commission intervention in standards-setting, no matter how well-intentioned, "runs a substantial risk that the regulatory 'solution' will end up harming consumers and competition in comparison with alternative, more flexible approaches."[79] Critically, the 3GPP process allows for the orderly development of new standards and modification of existing standards as the industry evolves, but "there is no ready escape clause available to the industry" from a flawed Commission mandate.[80] If, for example, the Commission were to require AT&T to use Band 12 and market experience confirms that it causes widespread consumer harms, there is little prospect that this error could be corrected before the industry had sunk the costs necessary to transition to Band 12.[81]

Rigid, Commission-imposed mandates "can also result in technological stagnation."[82] Again, in stark contrast to industry-driven, engineering-based standards, there is a real risk that regulatory mandates will remain in effect well beyond their useful shelf life. For example, as the Communications Liberty and Innovation Project explains, the Commission required cellular

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[76] CLIP at 5.

[77] *Accord*, CLIP at 5; CEA at 5-6; TIA at 6.

[78] Israel-Katz-Shampine Reply Decl. ¶¶ 31-34.

[79] Israel-Katz-Shampine Reply Decl. ¶ 9.

[80] Israel-Katz-Shampine Reply Decl. ¶ 31.

[81] Israel-Katz-Shampine Reply Decl. ¶¶ 32-33.

[82] CLIP at 6.

carriers to achieve interoperability using the AMPS standard and kept that requirement in place 27 years, "long after the technology had ceased being commercially viable."[83] Relatedly, a Commission mandate will undermine the prospect of industry-driven solutions, such as the development of new 3GPP standards that enable LTE networks to communicate simultaneously over multiple bands and that could thus address the A Block licensee's purported concerns but without the loss of service by existing devices.[84]

These concerns are only amplified when, as is proposed here, the Commission is being asked to reverse industry standards *after the fact*. "For sound reasons, the Commission's usual approach to interoperability is to specify whether interoperability will be required between bands prior to standards' being set and prior to investments' being made."[85] As noted, in setting the initial rules governing the Lower 700 MHz auction, however, the Commission did not impose any particular "interoperability" requirement but instead wisely adopted a "flexible use" policy that left it to the industry to adopt the standards that would govern the services provided in this spectrum.[86] Working through 3GPP, the industry established those standards including Band 17, after "a lengthy, multi-year process" that "considered the relative technical merits of a wide range of proposals before adopting the existing standard."[87]

The standards-setting process will be irreparably impaired if the Commission establishes a precedent under which it may, on an *ad hoc* basis, reverse the ground rules it set in auctioning

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[83] *Id.*

[84] Israel-Katz-Shampine Reply Decl. ¶ 34. As explained below, although such new standards may address the A Block carriers' stated concerns, those standards have not yet been finalized and, if adopted, could only be implemented with substantial investment of time and resources and after rigorous testing. *See infra* Subpart C.

[85] Israel-Katz-Shampine Reply Decl. ¶ 9.

[86] *See supra* n. 73.

[87] CEA at 8; *see also Notice* ¶¶ 7, 10.

the spectrum and countermand 3GPP standards by second-guessing the 3GPP's engineering judgments years after a standard has been implemented in the marketplace. "The negative impact of changing the rules now would discourage participation in future standards-setting efforts, and ultimately erode confidence in such processes and the standards adopted." [88] As a matter of fundamental economics, that in turn would reduce incentives to invest the vast sums necessary to develop wireless infrastructure equipment, wireless devices, and wireless services.[89] Industry participants will be inhibited from making these investments if they can be stranded by after-the-fact regulatory fiat. For the same reasons, "[e]liminating the use of a specific standard after licensees and equipment suppliers have already made substantial investments in the standard and associated equipment will undermine future incentives to bid for licenses at auction and to invest in network infrastructure."[90]

Finally, as economists Katz, Israel and Shampine demonstrate, once the Commission establishes that it is willing to act as a kind of "court of appeals" from the 3GPP process, such a precedent would create "a perverse feedback loop" by "send[ing] a signal that it is possible to engage in successful rent-seeking activities aimed at changing regulations/standards after the fact to gain competitive advantage." [91] The economic literature recognizes the harms to innovation that can occur when such rent-seeking activities are given free reign.[92] T-Mobile's filings here underscore this concern: it has *no* 700 MHz spectrum and its main interest in this proceeding appears to be retarding AT&T's deployment of broadband LTE networks to improve its own

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[88] *See* CEA at 8.

[89] Israel-Katz-Shampine Reply Decl. ¶ 26.

[90] *Id.* ¶ 9.

[91] *Id.* ¶¶ 28-29.

[92] *Id.* ¶ 28.

competitive position in the marketplace.[93] For this reason, too, the proposed mandate would undermine the Commission's stated goal of *encouraging* investment in wireless broadband infrastructure.[94]

B. The Only Reliable Record Evidence Confirms What Basic Principles of Wireless Engineering Predict: A Band 12 Mandate Would Subject AT&T To Substantial Interference From Channel 51 and the E Block.

The overwhelming record evidence confirms that high-powered transmissions from Channel 51 and E Block would cause harmful interference if AT&T's customers were forced to switch to Band 12 devices.[95] The only open question now is just how harmful that interference would be. The comments, particularly those filed by independent device and chipset manufacturers, confirm that harmful interference would be widespread and would significantly affect service quality, spectral efficiency and network capacity, and that mitigation efforts would be extremely costly and, at best, only partially effective.

1. Rigorous Engineering Studies Demonstrate That A Band 12 Mandate Would Subject AT&T And Its Customers To Substantial Interference.

a. E Block Interference

There has never been any serious dispute that an E Block network operating at 50 kW would cause debilitating interference for users of Band 12 devices. Indeed, it is telling that the A Block licensees all agree with AT&T that the Commission should act promptly to eliminate E

[93] T-Mobile at 3.

[94] Federal Communications Commission, *Connecting America: National Broadband Plan*, 5-9 (2010).

[95] AT&T at 27-35 & Reed-Tripathi Report at 9-16.

Block interference by applying the conditions imposed on AT&T in the *Qualcomm* proceeding to DISH's planned E Block operations.[96]

To the extent that the A block licensees and other proponents of the Band 12 mandate have contended in the past that interference issues raised by E Block transmissions can be ignored because it was not clear whether DISH – the owner of most E Block spectrum – would deploy a high-powered broadcast video network, DISH's comments eliminate any such contention. DISH expressly states that it "plans to deploy a broadcast video service in the E block" and that it intends to do so at the full 50 kW power that it is currently authorized to use.[97]

And the record now contains detailed engineering analyses that conclusively establish that, absent Commission action limiting the power level of DISH's inevitable E Block network, a Band 12 mandate would subject AT&T's LTE customers to disruptive E Block interference throughout the country. A "Band 17 filter provides 15,849 times more attenuation of the high-powered E block signal than the Band 12 filter can provide."[98] Qualcomm further demonstrates the extent to which Band 12 and Band 17 devices will suffer desensitization as a function of E Block signal strength.[99] According to that analysis, Band 12 devices will begin experiencing significant desensitization when they receive E Block signals of -49 dBm or stronger, whereas Band 17 devices will experience no or minimal desensitization even with signal strength as high as -6 dBm.[100]

[96] Cavalier at 14; Cricket at 11-12; NTCA at 9; U.S. Cellular at 19-20; *see also* T-Mobile at 18-19.

[97] DISH at 5, 6-9.

[98] *Id.* at 9.

[99] *Id.* at 10-11.

[100] *Id.* at 7-13.

Qualcomm further confirms that consumers using Band 12 devices will almost certainly encounter E Block power at these levels that cause significant degradation of service under a typical E Block deployment. Using drive testing data undertaken in connection with Qualcomm's own MediaFLO service (which operated up to 50 kW, the same power limit that governs E Block), Qualcomm demonstrates that Band 12 devices would experience degraded service at numerous locations under DISH's E Block deployment.[101]

Qualcomm also demonstrated that there is a likelihood not only of adjacent channel interference from Block E, but also of intermodulation interference.[102] Specifically, carriers operating in B, C or B/C Block uplink frequencies in the presence of E Block transmissions can be subject to intermodulation products that fall in A, B and C Block receive frequencies.[103] A Band 17 device will be much more effective in preventing this intermodulation interference, both by reducing levels of unwanted E Block transmissions that are received by a LTE device as well as attenuating intermodulation products that fall in A Block.[104] Qualcomm's analysis proves that a Band 17 device will be extremely effective at preventing Block E intermodulation interference whereas a Band 12 device would be subject to significant levels of performance-degrading interference at E Block transmission powers that are likely in a real world E Block broadcast deployment.[105]

Although the full extent to which AT&T would be subject to E Block interference cannot be known prior to DISH's actual deployment, Qualcomm's analysis confirms that large areas

[101] *Id.* at 13-18.

[102] *Id.* at 18-29.

[103] *Id.* at 20-21.

[104] *Id.* at 22-23.

[105] *Id.* at 23-29.

could be impacted. As noted, Qualcomm provides drive test maps showing the signal strength levels associated with Qualcomm's MediaFlo service, which has very similar operating characteristics to DISH's contemplated E Block service. To estimate the impact of the Band 12 mandate in these circumstances, AT&T used Qualcomm's drive test maps to estimate the portion of its broadband data traffic that could be negatively impacted by E Block interference in a representative market (Dallas-Forth Worth) if AT&T were required to provide service only over Band 12. Using Qualcomm's drive test results for its MediaFlo service, AT&T conservatively estimates that, if a comparable service is provided by DISH, more than a quarter of AT&T's data traffic in the Dallas-Fort Worth CMA would be in areas with E Block signal levels at or above the levels Qualcomm estimates would impact device performance.

b. Channel 51

Two independent laboratory tests conducted by leading wireless certification firms – PCTEST and 7Layers – demonstrate empirically that Band 12 devices are much less effective than Band 17 devices in blocking Channel 51 interference.[106] These tests, and the engineering analyses submitted by Qualcomm, confirm that at real world Channel 51 power levels, AT&T customers would experience substantially degraded service if required to use Band 12 devices.[107]

PCTEST was founded by former FCC engineers and provides equipment and device manufacturers with independent testing of both FCC regulatory obligations and industry standards.[108] 7Layers is a leading testing and certification firm, working with many leading LTE

[106] *See generally* Reed-Tripathi Reply Report & Exhibits A ("Testing Methodology"), B ("PCTEST Report") and C ("7Layers Report").

[107] Qualcomm at 6-55.

[108] Background, PCTEST, http://www.pctestlab.com/background.php (last visited July 14, 2012).

providers to verify conformity with 3GPP LTE specifications.[109] The methodology used, and results generated by, PCTEST and 7Layers are set forth in their accompanying reports and the Reed-Tripathi Reply Report.[110] These firms both measured the comparative performance of Band 12 and Band 17 versions of an actual commercially available LTE device operating in the presence of Channel 51 transmissions at signal levels that would be experienced in the real world.[111] The testing followed 3GPP guidelines for testing performance of LTE devices.[112] Both firms used a controlled lab environment with the state-of-the-art Rhode & Schwarz testing equipment widely used in the industry to evaluate the performance of mobile devices.[113]

That rigorous testing confirms that even under pristine lab conditions free of the "noise" that is experienced in real world operating conditions, the performance of Band 12 devices operating in the Lower 700 MHz B and C Blocks begins to degrade when subject to Channel 51 broadcasts power levels as low as -37 dBm.[114] The testing further showed that the potential effects of Channel 51 intermodulation on Band 12 devices become substantially more severe with modest increases in Channel 51 signal strength.[115] While the initial effect of this Channel 51 interference is to slow data transmission throughput speeds below 3GPP levels – and very quickly *by half or more* – relatively slight additional increases in Channel 51 signal strength can cause Band 12 devices to drop calls (starting at Channel 51 signal levels as low as -27 dBm) and

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[109] Wireless Engineering and Test Centers from 7Layers, *Interlab Test Solution LTE-USIM/USAT Covers Test Requirements of Almost All LTE Carriers World-Wide* (July 6, 2012), http://www.7layers.com/#!/blog-news/lte-usimusat-test-system-is-fit-for-all-networks.

[110] *See generally* Reed-Tripathi Reply Report at Exhibits A-D.

[111] Reed-Tripathi Reply Report at 9-13.

[112] *Id.*

[113] *Id.*

[114] 7Layers Report at 15; *see also* Reed-Tripathi Reply Report at 9.

[115] PCTEST Report at 14; 7Layers Report at 10, 14; *see also* Reed-Tripathi Reply Report at 9-13.

ultimately to lose the ability to even see the LTE network (starting at Channel 51 signal levels as low as -24 dBm).[116] In contrast, the testing confirmed that Band 17 devices will perform at or above 3GPP levels even in the presence of very strong Channel 51 signals.[117]

Qualcomm's analyses confirm these findings. Qualcomm used signal generators and mobile device amplifiers to measure empirically desensitization experienced by a LTE receiver as a function of Channel 51 signal strength.[118] It then used an engineering analysis to determine the extent to which Band 12 filters would be able to attenuate Channel 51 signals sufficiently to prevent desensitization.[119] That analysis demonstrated that "consumers may experience interference" in areas with Channel 51 signal levels of about -30 dBm.[120]

Qualcomm's testing also explodes the myth that Channel 51 broadcasts will cause reverse intermodulation interference only at the cell edges. It is often assumed that reverse intermodulation will occur only when the device is operating at the amplifier's highest gain state (*i.e.*, maximum power), which is thought to occur only at the edge of a cell where LTE signal strength is lowest. As it turns out, this assumption is doubly wrong: Qualcomm's testing confirms that device amplifiers can be operating at any gain state at any moment,[121] and it further shows that reverse intermodulation interference can be *greater* when an amplifier is operating at

[116] PCTEST Report at 14; *see also* Reed-Tripathi Reply Report at 9-13.

[117] PCTEST Report at 14; *see also* Reed-Tripathi Reply Report at 9-13.

[118] Qualcomm at 38-42.

[119] *Id.* at 38-42.

[120] *Id.* at 45.

[121] *Id.* at 54-55. Motorola also reports that according to its analysis, "reliance on Band 12 devices would significantly increase the area in which subscribers on Lower 700 MHz B and C Block networks would experience reduced performance and increased interference, the result of which is an increasing number of dropped calls and reducing data throughput." Motorola at 3.

a lower gain state.[122] Moreover, as Drs. Reed and Tripathi explain, an LTE device can be operating at a high gain state even when it is not at the cell edge. In short, harmful reverse intermodulation interference is possible throughout affected cells.[123]

The independent lab testing and Qualcomm analyses confirm that Channel 51 intermodulation would result in broad "no call" zones throughout the country, including major urban centers. Using the Commission's well-accepted Longley-Rice method[124] and DTV

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[122] Qualcomm at 47.

[123] This is another respect in which Wireless Strategies study, which incorrectly assumes that harmful reverse intermodulation can occur only when a device's amplifier is transmitting at the highest gain state, is unreliable. Wireless Strategies Report at 47. Device amplifiers may still produce non-linear transmissions at power levels less than maximum output. Reed-Tripathi Reply Report at 22-23. In fact, Qualcomm's testing shows that non-linearity can be *greater* when an amplifier is operating at a lower gain state than a higher gain state. Qualcomm at 47.

[124] *See* Qualcomm at 43 n.43. The Commission has found that the Longley-Rice methodology provides "a more accurate representation of a station's technical coverage areas because it takes into account such factors as mountains and valleys," *see, e.g.*, Memorandum Opinion and Order, *Mountain Broadcasting Corp.*, 27 FCC Rcd. 2231, 2233, n.8 (2012), and it has "proven to be highly accurate at predicting the field strengths of television stations at a location," *Report to Congress: The Satellite Home Viewer Extension and Reauthorization Act of* 2004, 20 FCC Rcd. 19504, ¶ 143 (2005). For these reasons, the Commission's rules repeatedly endorse use of the Longley-Rice method for the strength of TV broadcasts. *See, e.g.,* 47 C.F.R. § 73.613(j) (Longley rice used to demonstrate interference protection is not required by new broadcast station because interference will not be caused to existing Class A broadcast station); *id.* § 73.616(e)(1) (Longley-Rice methodology used to determine whether new digital TV station would cause interference with an existing station); *id.* §§ 73.616(f)(3) (Longley-Rice methodology used to determine whether a new digital TV station interferes with existing Class A station); *id.* § 73.622(e)(2) (Longley-Rice methodology used to determine the service area of digital TV stations); *id.* § 73.623(c)(2) (Longley-Rice methodology used to evaluate interference from digital TV allotment changes); *id.* § 73.623(c)(5)(iii) (Longley-Rice methodology used to evaluate interference to Class A stations from digital TV allotment changes); *id.* § 76.59 (Longley-Rice methodology used to support modifications to TV markets). The Commission has also relied on the Longley-Rice methodology to examine a duopoly waiver request, Memorandum Opinion and Order, *Heritage Media Services*, 13 FCC Rcd. 5644, 5648, ¶ 7 (1998), and granted Qualcomm's petition for a declaratory ruling to use Longley Rice to evaluate interference in its Lower 700 MHz service, Order, *In the Matter of Qualcomm Inc. Petition for Declaratory Ruling*, 21 FCC Rcd. 11683, ¶ 17 (2006).

Reception Maps tool,[125] Qualcomm demonstrated that, for a representative set of Channel 51 broadcast stations – including Chicago, Kansas City, and Providence – there would be substantial areas where expected Channel 51 signal levels in the location of the handset would be at or above levels that would cause harmful intermodulation interference in Band 12 devices.[126] The potential impact on AT&T could be enormous. AT&T estimates that approximately 70 percent of data traffic in the Chicago, Kansas City and Providence CMAs would be in the areas where Channel 51 signal levels are at or exceed -30 dBm.[127] This is a highly conservative measure given that lab testing shows that the harmful effects of Channel 51 intermodulation can be seen at Channel 51 signal strengths as low as -37 dBm.[128] In many areas, the Channel 51 signal levels predicted by Qualcomm are at or above levels that PCTEST's analysis shows would result in complete LTE failure.[129] And because intermodulation interference can result when a device is operating at any gain state – and because a device can be operating at any gain state at any time – these problems could occur even well within a cell and not merely at cell edges.[130]

[125] Qualcomm at 43-44.

[126] *Id.* at 43-54. Qualcomm also demonstrated that in commuter corridors, such as Montclair, NJ, Channel 51 signals are at levels that cause degradation in Band 12 devices, but not in Band 17 devices. *Id.*

[127] Reed-Tripathi Reply Report at 17-18 & Exhibit D. Harmful reverse intermodulation interference from Channel 51 is most acute in areas where an LTE provider is using B block spectrum, in addition to C block spectrum. Although AT&T does not own B block in Chicago, AT&T notes that Verizon is in the process of selling its B block spectrum for Chicago, and that the purchaser of that spectrum would thus be subject to maximum interference in Chicago under the proposed mandate. In this regard, even where AT&T owns both B and C Block, a call can be allocated B Block resources at any point during a call, even if it is initially allocated C Block resources.

[128] Reed-Tripathi Reply Report at 9-13; 7Layers Report at 14.

[129] Reed-Tripathi Reply Report at 9-13.

[130] *Id.* at 22-23.

As Professor Reed and Dr. Tripathi explain, these analyses undertaken by PCTEST, 7Layers and Qualcomm likely significantly understate the extent to which Band 12 devices will experience performance degradation relative to Band 17 devices, for multiple reasons. First, the PCTEST tests allowed the commercial LTE device to use all of the "physical resource blocks" (or "PRBs") that would be available for all users in a cell in an LTE deployment. In the real world, a user's device would typically be allocated far fewer PRBs in a cell, resulting in greater likelihood of lost connections at lower Channel 51 transmission levels.[131] This is confirmed by 7Layers testing, which showed that as fewer PRBs were allocated, the negative effects of Channel 51 interference became stronger.[132] Second, PCTEST and 7Layers did not account for throughput degradation caused by a device being forced to use lower-order modulation schemes.[133] Third, real-world noise levels often will be above those experienced in the controlled lab experiments, which will mean that Band 12 devices will experience performance degradation at much lower additional interference levels caused by Channel 51 transmissions.[134] Fourth, the FCC-approved propagation analyses conducted by Qualcomm focuses on *average*

[131] *Id.* at 9-13.

[132] *Id.* at 9-13; 7Layers Report at 14.

[133] As Professor Reed and Dr. Tripathi explain (at 5-6), good channel conditions enable the use of a high-order modulation scheme (*e.g.*, 16-Quadrature Amplitude Modulation (16-QAM) or 64-QAM) and little channel coding (*i.e.*, minimal redundancy), leading to higher throughput. In contrast, poor channel conditions resulting from a weak desired signal and/or high interference necessitate the use of a low-order modulation scheme (*e.g.*, Quadrature Phase Shift Keying (QPSK)) and heavy channel coding (*i.e.*, significant redundancy), leading to lower throughput. The PCTEST and 7 Layers lab tests use QPSK modulation for both downlink and uplink transmissions, and thus are conservative in that they do not reflect the fact that intermodulation interference can decrease throughput by causing a device to shift from high-order modulation schemes to low-order modulation schemes. In practice, Channel 51 interference will reduce the cell area where high throughput can be achieved, because high interference will cause degradation in the SIR and will reduce the area where a high-order modulation scheme and little coding can be exploited.

[134] Reed-Tripathi Reply Report at 9-13.

signal level likelihoods, not maximum signal levels.[135] Therefore, in many of the areas outside the areas where Qualcomm found average signal levels to be below -30 dBm, actual maximum signal levels could be *above* -30 dBm.[136]

c. The Wireless Strategies' Interference "Study"

As Professor Reed and Dr. Tripathi show in their attached report, the outlier interference results proffered by Wireless Strategies on behalf of the A Block licensees do not remotely contradict these conclusions. Even the preliminary review of that study conducted by Professor Reed and Dr. Tripathi revealed substantial, significant errors – most notably, that Wireless Strategies had not even tested a Band 12 device and thus does not purport to evaluate how an actual Band 12 device performs in the presence of E block and Channel 51 interference.[137] Further analysis of the Wireless Strategies study now reveals additional, fundamental methodological errors.

E-Block. The Wireless Strategies' study acknowledges that, relative to 3GPP specifications, E block signals exceeding -56 dBm "may degrade ... performance, causing bit errors or interrupting communications."[138] Wireless Strategies further reports that in Atlanta it observed E block signal levels that "are often greater than -56 dBm," and, indeed, many areas where signal levels exceed -16 dBm.[139] Wireless Strategies thus concedes that E block transmission levels exceed those that, under 3GPP standards, are expected to produce degradation of service for Band 12 (but not Band 17) devices.

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[135] *Id.*

[136] *Id.*

[137] *See* AT&T at 35-37 & Reed-Tripathi Report at 19-23; Qualcomm at 31-33, 55-57.

[138] Wireless Strategies Report at 20.

[139] *Id.* at 27-28.

Moreover, Wireless Strategies obtained these results based on a test of only a partial E block deployment. Greater E block signal levels – and hence greater interference to Band 12 devices – would be experienced in a fully deployed commercial E block network.[140] Wireless Strategies measured transmissions associated with DISH's experimental test bed in Atlanta, Georgia.[141] This mini-deployment is not comparable to DISH's planned commercial deployment.[142] Qualcomm's experience with its MediaFLO service – which represents an actual commercial deployment of a 50 kW system – indicates that a real world, commercial deployment by DISH would require many more transmitters operating at 50 kW than the four transmitters being used for DISH's experimental system and would result in much higher signal strengths than those measured by Wireless Strategies.[143] Further, one of the transmission facilities that comprises DISH's mini-deployment in Atlanta was not even operating at full power.[144] Thus, the areas in which a Band 12 device would be subject to interference would be substantially greater than under Wireless Strategies' (flawed) analysis.[145]

Wireless Strategies response is that the Commission should ignore 3GPP standards and specifications relating to maximum E block signal levels that Band 12 LTE devices are designed to withstand. Instead, Wireless Strategies argues that all commercial Band 12 devices will actually be able to withstand more interference than 3GPP specifications suggest. But Wireless Strategies provides no legitimate basis for the Commission to ignore 3GPP standards and simply

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[140] Reed-Tripathi Reply Report at 20-22.

[141] Wireless Strategies Report at 33.

[142] Reed-Tripathi Reply Report at 20-22.

[143] *Id.* at 19; Qualcomm at 32.

[144] *See* Wireless Strategies Report at 13.

[145] Reed-Tripathi Reply Report at 20-22; Qualcomm at 32.

assume that all Band 12 devices – including those that have not yet been developed – will be able to withstand more E block interference than set forth in the 3GPP standards.[146]

Wireless Strategies argument to the contrary is not even based on analyses of Band 12 devices. Rather, Wireless Strategies argues that AT&T's Band 17 devices already handle substantial interference from Verizon's Band 13 transmissions. But that only further undermines Wireless Strategies argument. As Professor Reed and Dr. Tripathi explain, interference is *cumulative*.[147] Thus, the fact that AT&T is already subject to significant interference from Verizon militates *against* subjecting AT&T to *additional* significant interference from Channel 51. Moreover, unlike a high-power broadcast interfering source, potential interference from another low-power mobile broadband network (like Verizon's) can typically be resolved through base station collocation or other network design measures.[148]

Wireless Strategies also purports to estimate the performance of a Band 12 device in the presence of high E Block transmission by using a Band 17 device and "remov[ing] the [devices'] filter from the equation."[149] Although Wireless Strategies fails to provide key details that would allow third parties to verify its asserted results,[150] it appears that Wireless Strategies subjected a Band 17 device to a 50 kW transmission generated from within the upper A and B Blocks (within the passband of Band 17 devices' RF filters), and examined the signal levels at which a Band 17 device receiving in the adjacent upper C Block would cease to work.[151] Wireless

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[146] Reed-Tripathi Reply Report at 24-25.

[147] *Id.*

[148] Reed-Tripathi Reply Report at 26-27. *See also* Qualcomm at 29-30.

[149] Wireless Strategies at 23.

[150] Reed-Tripathi Reply Report at 25-56.

[151] Wireless Strategies at 23.

Strategies states that its testing found that the Band 17 device can "handle" high signal levels generated from the A and B blocks.[152] Wireless Strategies thus concludes by analogy that a Band 12 device will work in the presence of high signal levels from the E block.[153]

This vague and undocumented test can be given no weight.[154] As shown by Qualcomm, tests based on actual commercially available filters used in Band 12 and Band 17 devices confirm that Band 12 devices will experience significant degradation in performance at E block signal levels of about -49 dBm, which even Wireless Strategies admits will frequently occur in a high power E Block deployment. Even beyond that, Professor Reed and Dr. Tripathi explain that the Wireless Strategies' "test" is conceptually flawed and provides no meaningful insights into the questions before the Commission.[155] The issue here is not whether a Band 12 device might "work" for some unspecified period of time in the presence of E Block interference (the Wireless Strategies' test), but the extent to which the performance of the Band 12 device will degrade relative to a Band 17 device. As noted, Band 12 filters provide far less attenuation of E Block transmissions than Band 17 filters. As a result, as the testing described above confirms, Band 12 devices will experience significant performance degradation at E Block signal levels where Band 17 devices will not. In all events, as Professor Reed and Dr. Tripathi explain, even the flawed results reported by Wireless Strategies indicate that Band 12 devices would, in fact, experience

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[152] *Id.* at 24.

[153] *Id.* at 25.

[154] Reed-Tripathi Reply Report at 25-26. For example, fundamental to the Wireless Strategies analysis is whether the tested device can "handle" a certain level of E Block interference, but that critical term is never explained or defined. *Id.* at 24-26.

[155] Reed-Tripathi Reply Report at 25-26.

substantial blocking at E Block signal levels that would occur in a commercial E Block deployment.[156]

Channel 51. Professor Reed and Dr. Tripathi also demonstrate that Wireless Strategies made fundamental errors in attempting to estimate Channel 51 intermodulation levels that would result from a Band 12 mandate. As with Block E, Wireless Strategies biased its results by using an unrepresentative market (Atlanta, Georgia).[157] The transmitter in the Atlanta market is located in Rome, Georgia, far outside any downtown areas.[158] But in many cities, such as Chicago and Kansas City, the Channel 51 tower is located in downtown areas.[159] No meaningful conclusions can be drawn without measuring signal levels in these scenarios.[160]

But even as to Atlanta, rather than try to measure plausible "worst case" scenarios, Wireless Strategies appears to have biased the results by only measuring signal strengths at least two kilometers from the tower and only at ground level "where Channel 51 signal levels are likely lowest and cellular signal levels are likely to be highest."[161] For example, Wireless Strategies did not measure signal strength in upper floors of commercial buildings where Channel 51 signal strength will be relatively high and cellular signal strength relatively low.[162]

Indeed, Wireless Strategies' own report confirms that it understated expected signal strength from Channel 51. In its report, Wireless Strategies points to TV signal level

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[156] Reed-Tripathi Reply Report at 26.

[157] *Id.* at 18-20.

[158] *Id.*

[159] *Id.*

[160] *Id.*

[161] *Id.*

[162] *Id.*

measurements made by Nokia in Finland.[163] But although Nokia was measuring signal levels for a station broadcasting at about *half* the power of Channel 51, the signal strength Nokia actually measured was generally much *higher* than what Wireless Strategies reports.[164] Similarly, Nokia noted that it tested ground level signal levels from a 12.5 kW low power television station (Channel 47 in Norcross Georgia) and found those signals to be as high as -21 dBm directly underneath the transmitter.[165] This finding further highlights the fact a 1 MW television station such as Channel 51 will produce very strong signals in areas close to the transmitter.[166]

Critically, Wireless Strategies did not seek to test actual devices or measure actual levels of reverse intermodulation interference. Instead, Wireless Strategies largely conducts a thought experiment. To guess how reverse intermodulation interference would impact a Band 12 device, Wireless Strategies used an unrecognized formula for measuring the power of the interfering reverse intermodulation product. "In fact, there is no recognized formula of measuring this type of interference."[167] No formula can currently account for all of the complex factors that contribute to reverse intermodulation.[168] The only valid way to determine the extent to which reverse intermodulation interference would occur is to actually *test* it. That is precisely what PCTEST, 7Layers and Qualcomm did—and their analyses show that Band 12 devices operating

[163] Wireless Strategies Report at 75-76.

[164] Reed-Tripathi Reply Report at 18-20.

[165] Wireless Strategies Report at 52-53.

[166] Reed-Tripathi Reply Report at 18-20.

[167] Qualcomm at 56.

[168] Reed-Tripathi Reply Report at 22-24.

in the B and C Blocks would be subject to substantial Channel 51 reverse intermodulation interference in a wide array of circumstances.[169]

In addition, Wireless Strategies' Channel 51 analysis simply assumed that Band 17 filters would provide the same level of attenuation as Band 12 filters.[170] In other words, it assumed the answer it wanted. In fact, Band 17 filters provide much greater attenuation of both Channel 51 and intermodulation products that fall in the A Block.[171]

d. The V-Comm Interference Report

V-Comm, L.L.C. ("V-COMM") has also now submitted a report purporting to analyze the relative impact of Channel 51 and E block signals on Band 12 and Band 17 devices.[172] This analysis was submitted one business day before the due date for filing reply comments in this proceeding. Consequently, AT&T and other parties obviously have not had sufficient time fully to evaluate the study. However, as Professor Reed and Dr. Tripathi explain, certain aspects of this paper stand out, and merit brief discussion here.[173]

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[169] Compounding this error, Wireless Strategies only considered average signal levels for the reverse intermodulation products it computed. But there can be wide variations in intermodulation signal level such that peak levels can cause substantial interference. Reed-Tripathi Reply Report at 22-24.

[170] Wireless Strategies Report at 58.

[171] Reed-Tripathi Reply Report at 22-24. Wireless Strategies made several other fundamental technical mistakes. It incorrectly assumed that Channel 51 intermodulation would be a problem only where AT&T is operating in both the B and C blocks; it focused on off-center transmissions that understate the actual impact of Channel 51 interference; and it based its Channel 51 interference conclusions on an insufficient sample of field measurements that were, in any event, too far away from transmitters to provide relevant information. Reed-Tripathi Report at 19-23.

[172] *See* Reply Comments of V-Comm, L.L.C. Prepared on Behalf of Cavalier Wireless, Continuum 700, King Street Wireless, MetroPCS Communications, Inc., and Vulcan Wireless, WT Docket No. 12-69 (July 13, 2012) ("V-Comm Report").

[173] Reed-Tripathi Reply Report at 27-29.

Foremost, the V-COMM Report confirms that there are large areas where Channel 51 signals will exceed -30 dBm and where high-powered E block signals would exceed -49 dBm, which, as explained above, are the signal levels PCTEST, 7LAYERS and Qualcomm found would cause degradation in performance for Band 12 devices (but not for Band 17 devices).[174] Consequently, the main focus of the V-COMM Report is to try to show that Band 12 LTE devices will not actually experience harmful interference at these signal levels. As Professor Reed and Dr. Tripathi point out, however, V-COMM's analysis is flawed in multiple respects.

The centerpiece of the analysis is a field test that purports to measure the impact of Channel 51 reverse intermodulation interference using Band 12 devices. V-COMM contends that it tested the impact of Channel 51 interference on Band 12 devices on U.S. Cellular's network in Waterloo, Iowa by first operating using only B block spectrum (where Channel 51 reverse intermodulation interference would not occur), then using B and C block spectrum (where channel 51 reverse intermodulation products would be produced). V-COMM asserts that it found no difference in performance, and it thus concludes that Band 12 devices operating on networks using the B and C blocks do not experience significant performance degradation in the presence of Channel 51 signals. These conclusions are erroneous, for multiple reasons.

First, these field tests were conducted in and around Waterloo, Iowa, which is located nearly 60 miles away from the nearest Channel 51 transmitter, which is in Cedar Rapids, Iowa (a separate CMA from Waterloo). Channel 51 signal levels in Waterloo are thus likely well below the levels that have been shown to cause degradation in performance for Band 12 devices, *i.e.*, above about -30 dBm. Indeed, the propagation modeling reported by V-COMM shows that Channel 51 signal levels in and around Waterloo are generally in the sub-70 dBm to -40 dBm

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[174] *Id.*

range, and that almost all of V-COMM's drive testing device performance measurements occurred in these areas where Channel 51 signal levels are predicted to be below -30 dBm.[175]

V-COMM points to a small number of field measurements that were in areas where the propagation modeling predicts Channel 51 signal levels above -30 dBm. But those appear to be areas near Cedar Rapids, and U.S. Cellular does *not* hold or operate C block spectrum in the Cedar Rapids CMA. Any measurements in and near Cedar Rapids with a B block only deployment (or an A and B block deployment) are thus meaningless, because the reverse intermodulation interference product is created by the mixing of C Block and Channel 51 transmissions. But even if U.S. Cellular were somehow operating in the C block in and around Cedar Rapids, there appear to have been only a small number of measurements in these areas, and because V-COMM reports only the overall averages of the field test readings, any poor performance measured in these areas would be masked by the large number of test points in areas where Channel 51 signal levels were well below -30 dBm.[176] In short, V-COMM's supposed Channel 51 field test provide only that in the *absence of strong Channel 51 signals (or E block signals)*, Band 12 devices perform fine. That is neither interesting nor relevant to the issues raised in this proceeding.

V-COMM's field analyses also appear to be jerry-rigged. For these analyses, V-COMM chose to rely on propagation modeling, rather than actual field test measurements of Channel 51 signal levels in these areas. That decision is curious, especially because elsewhere in V-COMM's report it includes the results of drive tests in Cedar Rapids proper near the Channel 51 tower. If V-COMM conducted field test measurements of channel 51 signal levels in Cedar

[175] *See* V-COMM Report, at 29.

[176] Reed-Tripathi Reply Report at 27-29.

Rapids, it presumably did (or at least could) conduct similar measurements for Waterloo at the same time it was taking its device performance measurements.[177]

V-COMM's analyses cannot be relied upon for the additional reason that it is conceptually flawed. It is well established that 10 MHz LTE deployments (*e.g.*, B and C blocks) are significantly more efficient than 5 MHz deployments (*e.g.*, B block only), and thus that the throughput available in a 10 MHz deployment will be not just double the throughput of a 5 MHz deployment (because double the amount of spectrum is deployed), but *more* than double. V-COMM's rough throughput distribution comparisons are meaningless, because any differences in throughput levels reflect the *net impact* of increased throughput due to greater efficiency and degraded throughput due to interference.[178]

Other results in the V-COMM Report are likewise highly questionable. Most fundamentally, the fact that V-COMM's lab test results are so vastly different from the results found by multiple other independent tests and analyses that have been conducted and reported in this proceeding raises significant red flags. For example, V-COMM concludes that Band 12 devices will be adversely affected by Channel 51 and E block transmissions only at signal levels that are far above the levels that testing by PCTEST, 7LAYERS, and Qualcomm found would cause Band 12 devices to experience severe performance degradation.[179]

Moreover, V-COMM omits critical information from its report that is needed to evaluate why it reached such different results from the three other independent tests.[180] For example, one

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[177] *Id.*

[178] *Id.*

[179] *Id.*

[180] *Id.*

of the most critical values when using lab tests to measure Channel 51 interference is the LTE signal level (from the base station to the device).[181] It takes higher Channel 51 signal levels to cause interference where LTE signal levels are highest. According standard testing procedures, when measuring device performance in response to interference, LTE signal levels should be set at the level where the tested device is just able to detect the signal and receive packets (known as the device's reference sensitivity), plus an additional 3 dB.[182] By adding 3 dB, the LTE signal levels used in the test are those that typically occur in the areas between the cell mid-point and cell edge.[183] These are the LTE signal levels used in the PCTEST and 7LAYERS tests.[184] If V-COMM used higher LTE signal levels, V-COMM was effectively measuring the impact of interference much closer to the cell, which would explain why it found Band 12 devices to be able to withstand much higher Channel 51 and E block signal levels.[185] V-COMM, however, does not identify the LTE signal levels it used in its tests. Nor does V-COMM identify how it measured or computed the desensitization values it relies upon for its conclusion that the performance of Band 12 devices does not significantly degrade in the presence of Channel 51 signals. As discussed above, desensitization is a measure of degradation in device performance in the presence of an interfering signal. It is difficult to properly measure desensitization, and V-COMM provides no explanation as to how it did so.

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[181] *Id.*

[182] *Id.*

[183] *Id.*

[184] *Id.*

[185] *Id.*

2. Mitigating The Effects Of Channel 51 and E Block Interference Would Be Extremely Costly And Could Never Fully Eliminate Such Interference.

Some commenters suggest that mitigating Channel 51 and E Block interference would not be difficult,[186] but those assertions proceed from the assumption that these sources will not cause any significant interference. As explained above, the opposite is true.

Moreover, as AT&T demonstrated, the potential costs of addressing Channel 51 and E Block interference are staggering. "Even if the interference concerns required AT&T to increase its number of cell sites nationwide by only a small percentage, such mitigation costs could quickly exceed one billion dollars."[187] There would also be substantial opportunity cost: AT&T would be required to divert resources from other important projects, including construction of cell sites where they are most needed to address capacity and coverage issues.[188]

AT&T also demonstrated that it would be effectively impossible fully to ameliorate interference from Channel 51 and E Block. It is difficult to find new locations for cell sites and even where they can be found, it can take years to obtain the necessary permits and deploy a new site.[189] E Block interference would be particularly challenging to combat because AT&T has not factored the possibility of E Block broadcasts into its network planning and E Block operators can deploy multiple transmitters throughout a city.[190]

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186 Cellular South at 14; MetroPCS at 12; T-Mobile at 18.

187 AT&T at 32 (citing Wolter Decl. ¶ 51); *see also* Motorola at 2 (noting the "improved sensitivity for Band 17 over Band 12 devices … translates to reduced capital expenditure for deploying a regional or nationwide network in Band 17 versus a network with equivalent coverage for Band 12.").

188 AT&T at 33 & Wolter Decl. ¶ 36.

189 AT&T at 33 & Wolter Decl. ¶ 46.

190 AT&T at 34 & Wolter Decl. ¶ 50.

Qualcomm confirms that harmful interference from high powered sources cannot be solved with base station additions. Qualcomm explains that "collocation" is not a viable strategy for addressing Channel 51 and E Block interference. Collocation cannot be used to address Channel 51 interference "because Channel 51 transmitters operate at far higher power (1 MW) and aim to produce very different coverage patterns."[191] These high powered broadcasts can cause widespread areas with reverse intermodulation.[192] In contrast, the reason why cellular operators can mitigate interference through collocation with each other is because their cellular transmissions are of similar power and propagation.[193] Collocation is not a viable option to counteract for E Block interference either.[194] Indeed, collocation is particularly problematic in the E Block context because LTE carriers have already begun deploying base stations but E Block service has not yet begun.[195] With the deployment of each new E Block transmitter, AT&T's attempts to combat the resulting interference would become an expensive game of "whack-a-mole."

Finally, Qualcomm's analysis suggests that deploying additional base stations in an attempt to boost the strength of AT&T's LTE signal relative to the interfering signals may accomplish little. The theory behind such mitigation techniques would be to limit the instances in which a wireless device operated at the highest gain state and thereby reduce the likelihood of nonlinear operation that contributes to reverse intermodulation. As noted above, Qualcomm's

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[191] Qualcomm at 57.

[192] *Id.*

[193] Reed-Tripathi Reply Report at 26-27.

[194] Qualcomm at 30.

[195] *Id.* at 31.

testing shows that there is little correlation between gain state and nonlinear operation, and that "a device may utilize any gain level at any given moment."[196]

Moreover, it is worth repeating that AT&T – and not the A Block licensees – would be required to bear the enormous costs of complying with the proposed mandate – including the extraordinary costs of trying to ameliorate the impact of increased interference – as well as the loss of goodwill because of the negative impact of the mandate on the quality of the LTE services it provides.[197] The mandate thus would tilt the competitive playing field against AT&T and distort competition in the marketplace.[198] Indeed, the mandate's "adverse quality and cost effects would weaken the competitive pressures that AT&T bring to bear on rival wireless carriers, such as MetroPCS, Sprint, T-Mobile, US Cellular and Verizon Wireless, thus weakening rivals' incentives to provide high-quality services at low prices."[199] This is the exact opposite of sound economic policy.[200]

C. The Highly Abbreviated Transition Period Proposed By A Block Licensees Would Strand Millions Of Band 17 Devices.

While it would thus be remarkably poor, customer-harming public policy to force AT&T exclusively to utilize Band 12, if the Commission nonetheless were to do so, a substantial transition period would be necessary to avoid stranding millions of existing Band 17 devices being used by consumers today (and millions more in the pipeline) that cannot receive and transmit over Band 12.

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[196] *Id.* at 54.

[197] *See* Israel-Katz-Shampine Reply Decl. ¶ 11 (documenting extent that wireless customers care about network quality).

[198] *Id.* ¶¶ 9, 17.

[199] *Id.* ¶ 9.

[200] *Id.*

Remarkably, although several A Block licensees argue in favor of an even shorter transition than the two year period suggested in the *Notice*[201] – indeed, their trade association demands that interoperability be mandated by the end of the year[202] – they make no attempt to address whether such an abbreviated transition period would allow AT&T to put in place the network upgrades necessary to continue to provide service to millions of Band 17 devices. Nor could they. As AT&T demonstrated, no standard exists that would allow AT&T's network to broadcast simultaneously to both Band 12 and 17 devices.[203] And while multiple Frequency Band Indicator features are being developed that would allow AT&T's network to provide service to both Band 17 and Band 12 devices, that standard is just emerging and would almost certainly take much longer to implement than the two-year period proposed in the *Notice*.[204]

The only A Block licensee to even attempt to come to grips with this issue is Vulcan, but the "fix" it proposes to move customers from relatively interference-free Band 17 devices to interference-plagued Band 12 devices is technologically infeasible.[205] Vulcan recognizes that AT&T must be allowed to continue to serve its Band 17 devices, and suggests that this can

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[201] Blooston Rural Carriers at 11; King Street Wireless at 18; *see also* RTG at 14 (arguing "[t]ime is of the essence").

[202] RCA at 6.

[203] AT&T at 23; Wolter Decl. ¶ 15; *see also* Motorola at 4. This fact alone forecloses the A Block licensees' suggestion that AT&T should have already begun working on transitioning to Band 12. *See* King Street at 18. Moreover, reliance on such an argument would be patently arbitrary and illegal. The Commission lacks authority to enact retroactive rules, *cf. Bowen* v. *Georgetown Univ. Hosp.*, 488 U.S. 204, 208 (1988), and therefore it cannot justify an unreasonably short compliance deadline by on the ground that regulated parties should have anticipated and begun to comply with a rule before it was promulgated.

[204] AT&T at 24; Wolter Decl. ¶¶ 15-39; *see also* Motorola at 4 (noting that a standard to enable a base station to signal support of more than one band "does not currently exist").

[205] Vulcan Comments at 38.

accomplished with “minor modifications.”[206] According to Vulcan, “legacy Band Class 17 devices could be upgraded to recognize Band Class 12 base stations and channel numbers through a remote software update.”[207]

The assertion is, in a word, preposterous. Such a remote “update” is not technically feasible today and, even if it were, there would be substantial impediments to the implementation of such an update. Further, even if such an “update” was technically feasible, and the impediments to implementation were somehow overcome, such an “update” would result in the creation of “fake” Band 12 devices, causing operational issues that would have a substantial negative impact on the value of A Block spectrum. At a minimum, the type of update proposed by Vulcan would almost certainly lead to loss of LTE service for a substantial number of customers and impose substantial costs on AT&T.

Technical Feasibility. As Messrs. Prise and Howard explain in their accompanying declaration, the proposed “update” is vaporware. AT&T is not aware of any existing software that could be installed on existing Band 17 devices that would make them act as Band 12 devices.[208] Nor is it clear that such software even could be developed or deployed to the devices over the air as Vulcan suggests. The proposed update would make a fundamental change to a device’s air interface and affects the critical signaling functionality of the device. And, AT&T is not aware of any instance in which any carrier has been able to make such a fundamental change to a wireless device using over-the-air updates, let alone over-the-air updates to numerous different devices used by very large numbers of customers.

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[206] *Id.* at 37-38.

[207] *Id.* at 38.

[208] Prise-Howard Reply Decl. ¶ 27.

Rather, Vulcan's suggestion that such software updates could be created for each and every Band 17 device on AT&T's network is based on nothing more than bald speculation. And contrary to this speculation, it is quite clear that many Band 17 devices cannot be updated. As Mr. Prise explained in his previous declaration, AT&T is in the process of certifying various LTE-compatible modules that third parties use in their own devices (*e.g.*, laptops, routers, set-top boxes). It is AT&T's understanding that these modules are not able to receive the type of updates hypothesized by Vulcan.[209] Eliminating Band 17 would render these devices inoperable.

Impediments To Development. Even assuming that the software theorized by Vulcan could be developed and downloaded over-the-air to all necessary devices, there would remain enormous and potentially insurmountable obstacles to the process. First, there is no guarantee that all of the required device manufacturers would devote the resources necessary to develop the necessary software. They might well have other priorities for their research and development. And even assuming that device manufacturers did undertake development of the necessary software, developing the type of "update" postulated by Vulcan would almost certainly take more than a "few months."[210] This would be, after all, highly specialized work requiring highly specialized engineers and programmers who might well be tasked to different projects and thus not immediately available.[211] Of course, even after the software is developed, it would require rigorous testing before it could be downloaded since a glitch or failure to perform could render a device non-functional (or at least non-functional for LTE).[212] Further complicating matters, as

[209] *Id.* ¶ 28.

[210] Vulcan at 38.

[211] Prise-Howard Reply Decl. ¶ 31.

[212] *Id.* ¶ 32.

explained below, is that AT&T could not begin deploying any software updates until *all* manufacturers had completed their respective updates.[213]

Impediments To Implementation. There also would be substantial logistical impediments to actually deploying this hypothetical software, even assuming it could be developed and successfully tested. Any over-the-air update would have to be accomplished instantaneously and comprehensively. Unless *all* devices and *all* base stations are converted to Band 12 at the same instant, some customers' devices simply would lose LTE service. That is because once a Band 17 device was converted to Band 12, it would not be able to transmit or receive LTE data until AT&T converted its base stations to Band 12; conversely, if AT&T converts its base stations to Band 12 before a Band 17 device is "upgraded" to Band 12, then that device cannot transmit or receive LTE data.[214] Vulcan simply assumes that such a ubiquitous and instantaneous upgrade could be accomplished.

As Prise and Howard explain, Vulcan is wrong.[215] AT&T does not have sufficient network capacity to push a complex software update simultaneously to millions of devices.[216] "AT&T's experience is that over the air updates of only 20 MB, which are far less complicated than those proposed by Vulcan, can be pushed out to only about 70,000 subscribers per day."[217]

Further, numerous customers would not receive the update. Many devices inevitably would be turned off; others would be outside the area where the update is occurring (*e.g.*, outside

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[213] *Id*. ¶ 31.

[214] *Id.* ¶¶ 33-37.

[215] *Id.*

[216] *Id.* ¶ 34.

[217] *Id.*

the country or roaming); and others would be operating on Wi-Fi.[218] It is also quite likely that, given its complexity, the update would not be successfully installed.[219] AT&T's experience with over-the-air updates far less complex than the one Vulcan is proposing is that the update would not be successful for a substantial fraction of its customers.[220] As noted, those customers would not be able to receive LTE service and would "require *ad hoc* over the air updates or in-store updates, or some combination of the two."[221]

Operational Issues Created by "Fake" Band 12 devices. Even if it were possible to develop an over-the-air-update to cause Band 17 devices to transmit and receive over Band 12, and the implementation obstacles could be overcome, the updates would not change the underlying core hardware of the Band 17 devices. Instead, the best that could be achieved would be the creation of "fake" Band 12 devices. The creation of such devices would cause substantial operational issues – issues that would actually undermine the value of A Block spectrum.

Although the update envisioned by Vulcan would cause AT&T's legacy handsets to advertise themselves as Band 12 devices, they would not actually be Band 12 devices.[222] These devices would still have Band 17 filters that would serve to block (or substantially attenuate) A Block transmissions.[223] Thus, unlike true Band 12 devices, the "fake" Band 12 devices Vulcan envisions would not be operable (or would not operate properly) if they were assigned resources

[218] *Id.* ¶ 36.

[219] *Id.* ¶ 35.

[220] *Id.*

[221] *Id.* ¶ 37.

[222] *Id.* ¶ 38.

[223] *Id.*

in A Block.[224] In this respect, such devices would not comply with 3GPP specifications for Band 12 devices.[225]

Such "fake" Band 12 devices would create substantial operational issues for any carrier that wants to utilize A and B/C Block spectrum in a location.[226] In such circumstances, these "fake" Band 12 devices would present themselves to the network as being able to send and receive transmissions over A Block, but if the network were to allocate A Block resources to those devices, the data transmission would not be successful.[227] These problems would only multiply with the deployment of carrier aggregation as that would increase the likelihood that a "fake" Band 12 device could be assigned some A Block resources.[228]

Significant Harm To AT&T. Finally, even if all of these real world barriers could simply be assumed away, requiring AT&T to undertake the proposed over-the-air update would cause AT&T substantial harm. First, AT&T likely would have to pay substantial sums to give its various LTE device manufacturers the incentive to develop the updates (which would increase to the extent the Commission imposed an arbitrary deadline).[229] Second, AT&T would also incur very substantial testing costs.[230] Third, AT&T would suffer extraordinary harm to its goodwill from the instances in which the update was not received/did not function properly, leaving the device unable to access the LTE network.[231]

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[224] *Id.* ¶¶ 38-39.

[225] *Id.* ¶ 38.

[226] *Id.* ¶ 39.

[227] *Id.*

[228] *Id.*

[229] *Id.* ¶ 40.

[230] *Id.* ¶ 41.

[231] *Id.* ¶ 42.

III. THE SPECIFIC BAND 12 MANDATE THAT THE A BLOCK CARRIERS SEEK WOULD BE UNLAWFUL.

AT&T's opening comments demonstrated that the proposed elimination of Band 17 – which would subject AT&T's customers real and substantial interference from Channel 51 and E Block broadcasts[232] – violate the terms under which the Commission auctioned the 700 MHz spectrum and would be an unlawful retroactive modification of AT&T's licenses. The mandate proponents offer no significant response to AT&T's showing – they ignore the controlling legal principles and instead rely upon a hodgepodge of statutory provisions and decisions that are simply irrelevant.

The controlling legal principles are clear. Notwithstanding the Commission's broad authority to manage spectrum, Section 309(j) of the Communications Act sets forth specific provisions governing the auctioning of spectrum, including the auctioning of the Lower 700 MHz spectrum. The Commission may not schedule competitive bidding for spectrum unless it has first defined the spectrum that is to be auctioned, established bidding rules, and allowed an "adequate period" to "ensure that interested parties have a sufficient time to develop business plans, assess market conditions, and evaluate the availability of equipment for the relevant services."[233] As the D.C. Circuit has thus started, "we start from the intuitive premise that an agency cannot, in fairness, radically change the terms of an auction after the fact."[234]

But that is exactly what the proposed mandate would do. Prior to the 700 MHz auction, the Commission described the characteristics of the different blocks of spectrum within the band, making clear that the spectrum it was auctioning was far better insulated from high-power

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[232] AT&T at 37-43.

[233] 47 U.S.C. § 309(j)(3)(E).

[234] *U.S. Airwaves, Inc.* v. *FCC*, 232 F.3d 227, 235 (D.C. Cir. 2000).

broadcast sources than the Lower A Block Spectrum.[235] This spectrum was auctioned off under rules that allowed winning B Block bidders to use "equipment for the relevant services" – *i.e.*, devices – that take advantage of the characteristics of this spectrum. Indeed, all bids were made against the background of the Commission's longstanding "flexible use" policies that allow carriers to design their networks and devices in the ways that they believe will best serve their customers.[236] The Commission also repeatedly warned A Block bidders of the interference issues that they would face,[237] and B Block spectrum was purchased for much higher prices than A Block.[238]

Having auctioned off B Block licensees under rules that allow the winning bidders to use devices that take advantage of the characteristics of this spectrum, the Commission cannot now require B Block licensees to use devices that will subject them not just to greater interference risks, but also the very same interference sources that have impeded the deployment of LTE services on A Block spectrum. That would be a prohibited retroactive change in the terms of the auction and would also violate the rule that the Communications Act is designed to foster "*competition*," not to help individual "*competitors*" at the expense of others.[239]

Regulatory proponents simply ignore these controlling principles and instead rely on Commission decisions and statutory provisions that provide no justification for the mandate.

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[235] *E.g.*, *First Lower 700 MHz Order* ¶¶ 23, 76-85, 104.

[236] *See supra* n. 72.

[237] *E.g.*, *First Lower 700 MHz Order* ¶ 23.

[238] AT&T at 39 n. 115 (winning B Block bids were over two times higher than winning A Block bids).

[239] Memorandum Opinion and Order, *In re Applications of Craig O. McCaw, Transferor, and American Tel. & Tel. Co., Transferee*, 10 FCC Rcd. 11786, ¶ 9 (1995); *SBC* v. *FCC*, 56 F.3d 1484, 1491 (D.C. Cir. 1995); Order, *Applications of Motorola, Inc. for Consent to Assign 800 MHz Licenses to Nextel Commc'ns, Inc.*, 10 FCC Rcd. 7783, ¶ 20 n. 58 (1995).

Their principal claim is that the proposed mandate is "no different" than the interoperability requirement that the Commission adopted for 800 MHz spectrum in the early 1980s.[240] That is nonsense. The Commission imposed interoperability conditions on cellular licenses *before* they were awarded (for free).[241] This decision provides no justification for a mandate that would retroactively change the terms of an auction years after it was completed and years after the winning bidders had begun providing service over that spectrum.

For the same reason, proponents are wrong in arguing that the proposed mandate is supported by the Commission's Order that imposed an "open access" requirement on 700 MHz Upper C Block licensees before that spectrum was auctioned.[242] Indeed, if anything, this precedent forecloses imposition of a Band 12 mandate. The Commission in that Order expressly rejected imposition of an open access requirement on the Lower B Block licenses that AT&T bought in the auction.[243] The fact that the Commission imposed such an obligation for Upper C Block prior to the auctioning of that spectrum but rejected an "interoperability" requirement as to the Lower B Block only underscores the retroactive, after-the-fact nature of the mandate being advocated now.

Proponents also argue that the mandate is authorized by the prior Commission decision requiring carriers to make data roaming services available on reasonable terms.[244] But again, this precedent cuts against the proposed mandate. Under the *Data Roaming Order*, a carrier that

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[240] Cricket at 5; T-Mobile at 22; *see also* Cellular South at 3-4 ("[T]oday's industry conditions are exactly like those that the FCC sought to guard against in the 1980s.").

[241] Report and Order, *In the Matter of Inquiry into the Use of the Bands 825-845 MHz and 870-890 MHz for Cellular Communications Systems*, 86 F.C.C. 2d 469 (1981) ("*Cellular Order*").

[242] *Compare* Cricket at 5.

[243] *Second Lower 700 MHz Order* ¶ 195.

[244] Cellular South at 3 & n.2; Cricket at 5 & n.16; *see* T-Mobile at 23 (claiming mandate is authorized because it would "facilitate" roaming).

wishes to roam on other networks is responsible for providing its customers with devices that are capable of operating both on their home networks and the networks of the roaming partners – and as detailed above, A Block carriers have many such options. In so finding, the Commission in the *Data Roaming Order* rejected the notion that a carrier should have to modify its network to enable roaming by another carrier.[245] The Commission's data roaming rules thus assuredly do not require carriers to jettison the devices that they were authorized to use when they acquired its spectrum and to instead provide devices that would subject the carriers to the harmful interference that they paid billions of dollars to avoid, contrary to Section 309 and the principles announced by the D.C. Circuit.

Finally, the statutory provisions cited by regulatory proponents simply have no relevance. They rely on the provisions of Sections 301, 303, 304, 307 and 309 that give the Commission authority to "prescribe the nature of the service" offered by each "class of licensed service,"[246] and "condition [its] licensing actions" on certain "operational requirements."[247] As AT&T explained,[248] such provisions do no more than give the Commission the authority to impose certain conditions *before* new licenses are granted and to interpret and enforce requirements that are consistent with the terms of previously granted licenses. Indeed, as explained above, Section 309(j)(3)(E) forecloses the Commission from "radically chang[ing] the terms of an auction after the fact."[249]

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[245] *Data Roaming Order* ¶ 43.

[246] Cellular South at 7-8 (*citing* 47 U.S.C. §§ 301).

[247] T-Mobile at 22-23 (citing 47 U.S.C. §§ 301, 303(b), 304, 307(a), 309(j)(3)). T-Mobile is, however, correct that the Commission has authority under Sections 302(a), 303(e) and 303(f) to "regulate and prevent interference." T-Mobile at 23. But that is fatal to the mandate, which would *produce* interference in the B and C Blocks. *See* AT&T at 41.

[248] AT&T at 40-42.

[249] *U.S. Airwaves*, 232 F.3d at 235.

Cellular South, Cricket and T-Mobile also claim that the proposed mandate is authorized by statements regarding the purposes of Title III contained in Section 301 and 303(r).[250] But the D.C. Circuit has held that neither of these provisions are grants of regulatory authority to the Commission, so neither could authorize the proposed mandate.[251]

Cellular South's citation to provisions of Title II is even further afield. Cellular South argues that AT&T's failure to purchase and resell A Block devices has violated Section 201(b), which prohibits unjust or unreasonable practices in common carrier communications services, and Section 202(a), which prohibits unjust or unreasonable discrimination in the provision of these services."[252] These provisions only apply to "common carriage" and are thus inapplicable to contracts between a wireless carrier and an equipment provider.[253] And, in all events, there is nothing remotely unreasonable or unreasonably discriminatory about failing to purchase devices that would be subjected to degraded service quality from Channel 51 and E Block interference.

Cellular South undoubtedly understands the irrelevance of the foregoing provisions, and it ultimately claims that the proposed mandate is authorized by Section 316(a), which provides that licenses may be "modified" by the Commission.[254] But this provision, too, is inapposite.

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[250] Cellular South at 7-8; Cricket at 3; T-Mobile at 22-23. Specifically, they point to section 301's statement that the purpose of Title III is to authorize regulation of the Commission of "radio communications" and "transmission of energy by radio" and Section 303(r)'s statement that the Commission may "[m]ake such rules and regulations and prescribe such restrictions and conditions . . . as may be necessary to carry out the provisions of this Chapter." 47 U.S.C. §§ 301, 303(r); *see also Notice* ¶¶ 56, 58 & n. 153.

[251] *Comcast Corp.* v. *FCC*, 600 F.3d 642, 652-54 (D.C. Cir. 2010) (section 301's statement of purpose are not grants of regulatory authority); *Motion Picture Ass'n of Am., Inc.* v. *FCC*, 309 F.3d 796, 806 (D.C. Cir. 2002) (the FCC cannot adopt rules under Section 303(r) "if the agency does not *otherwise* have the authority to promulgate the regulation at issue.")

[252] Cellular South at 6-7.

[253] *See, e.g., Cellular Order* ¶¶ 58-61.

[254] Cellular South at 8 (*citing* 47 U.S.C. § 316).

"Modif[ication]" means to change carriers' obligations "moderately or in minor fashion,"[255] and the Commission's modification authority under Section 316 does not include the power to "fundamental[ly] change" the nature of the service that a licensee is authorized to provide.[256] Here, the proposed mandate would compel B and C Block licensees to offer handsets that would subject them to the risks of harmful interference that A Block bidders voluntarily assumed and that B and C Block licenses paid billions of dollars to avoid. That would be a fundamental change in a license, not a "modification."

In short, the Commission cannot lawfully adopt the proposed mandate. Rather than conduct further proceedings to address this unlawful proposal, the Commission should exercise its undoubted authority (under Sections 302(a) and 303(e) & (f)) to evaluate the potential interference to Lower 700 MHz wireless from high powered broadcasts over Channel 51 and E Block and to order those steps that can lawfully be taken to mitigate or eliminate those potential harms.[257]

IV. THERE IS BROAD AGREEMENT THAT THE COMMISSION SHOULD FOCUS ON ELIMINATING CHANNEL 51 AND E BLOCK INTERFERENCE.

The Commission should focus on eliminating the sources of interference in the Lower 700 MHz spectrum band, which in turn will enhance the value of the entire band. Doing so will not only remove the only real impediment to broader LTE deployment by A Block licensees but

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[255] *MCI Telecomms. Corp.* v. *AT&T Co.,* 512 U.S. 218, 225 (1994).

[256] *Cmty. Television, Inc.* v. *FCC*, 216 F.3d 1133, 1141 (D.C. Cir. 2000).

[257] Cellular South contends that AT&T "conceded" that the Commission could lawfully adopt the proposed Band 12 mandate when AT&T filed a motion to dismiss the antitrust action in which Cellular South has sought injunctive relief against AT&T and other defendants in federal district court in Mississippi. Cellular South at 9. Cellular South is confused. By stating that the antitrust action is inconsistent with the Commission's authority over "spectrum policy," AT&T was referring to the Commission's primary jurisdiction Commission over spectrum policy and not to lawfulness of the specific proposed mandate.

also create the conditions that will allow the industry to work voluntarily toward more interoperable solutions. Once Channel 51 and E Block interference issues are appropriately addressed, "an industry solution is likely to emerge for interoperable equipment in the Lower 700 MHz band without the need for equipment mandates."[258] Even the A Block licensees recognize this fact.[259]

In its comments, AT&T set forth some suggested proposals for addressing both Channel 51 and E Block interference, and other commenters provided some initial suggestions as well. Indeed, there is broad unanimity of agreement that the Commission should make these efforts a priority.

Channel 51. Interference from Channel 51 – not a lack of availability of Band 12 handsets – is deterring A Block licensees' deployment of LTE networks.[260] Substantial portions of A Block spectrum cannot be used because they are within very large, Commission-designated

[258] Verizon at 3; *see also* RIM at 14-15.

[259] *See* MetroPCS at 12 (MetroPCS "believes that the resolution of Channel 51 interference issues will vastly increase the chances of an industry solution"); *see also* Cavalier at 14 (stating that eliminating interference concerns will "facilitate" voluntary interoperability).

[260] *See, e.g.*, Comments of Vulcan Wireless LLC and the Rural Telecommunications Group, Inc.. RM-11626, at 4-5 (April 27, 2011) (full power Channel 51 television transmissions have the potential to "interfere with nearby A Block base station receivers," but "Class A and LPTV stations operating on Channel 51 *also* pose serious interference risks to nearby A Block base stations because of their high power levels (relative to A Block transmitters), proximity to more densely populated areas, and the fact that they are generally deployed low to the ground. . . ."; "[i]n some cases, the interference effects from the far greater number of 125 Class A and LPTV stations can be more damaging than from full power stations"); Letter from Kathleen Grillo, Verizon, to Rick Kaplan, FCC, WT Docket No. 12-4, at 3 (May 22, 2012) (Verizon has "communicated with equipment vendors about procuring both devices and network equipment that will operate on the Lower 700 MHz A and B blocks," but "deploying service on some of the Lower A Block licenses is complicated by FCC rules that require A Block licensees to avoid interference to adjacent full power TV Channel 51 operations and that set exclusion zones").

exclusion zones around Channel 51 broadcast towers.[261] Indeed, the Channel 51 exclusion zones are so extensive that in some cases A Block licensees contend that it is practically impossible for them to meet their build-out requirements.[262] As a result, potentially valuable spectrum that could be used to alleviate growing capacity constraints lies fallow.

Although the Middle Class Tax Relief and Job Creation Act of 2012 ("Spectrum Act") authorized the Commission to undertake "reverse auctions" that could potentially clear Channel 51, those auctions cannot be conducted for several years and cannot solve the immediate need for A Block spectrum. Thus, AT&T urged the Commission to take immediate action to address Channel 51 interference in advance of the Spectrum Act auctions.

There was broad support in the comments for AT&T's position.[263] And, as AT&T explained, there are a number of flexible programs that the Commission could adopt that would encourage voluntary relocation by Channel 51 broadcasters in the immediate future while preserving the broadcasters' statutory rights to participate in and benefit from the Spectrum Act reverse auctions and to exercise must carry rights.[264] For example, Channel 51 licensees could be allowed to cease broadcasting, move to another channel under a temporary, provisional license, or be given the option to share with another channel on a different frequency.[265]

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[261] *See* Letter from Tamara Preiss, Verizon, to Marlene H. Dortch, FCC, WT Docket No. 06-150, RM-11592 (Sept. 1, 2011) (providing examples of limitations in the ability to provide LTE services using 700 MHz A Block because of Channel 51 exclusion zones).

[262] *See id.*, Attachment at 3-4.

[263] *See* Blooston Rural Carriers at 5; Cavalier at 14; Cricket at 10-11; CTIA at 4-6; King Street at 16; Metro PCS at 12; NTCA at 8-9; RIM at 14; RTG at 13; U.S. Cellular at 21.

[264] In this regard, there would be no absolute barrier to foreign-controlled carriers purchasing a Channel 51 Station in advance of the Spectrum Act auction. Section 310(b)(4) gives the Commission express authority to waive the Communications Act's limits on foreign ownership of broadcast stations where doing so would be in the "public interest."

[265] AT&T at 46.

Alternatively, as AT&T explained, where a Channel 51 licensee wished to sell its license prior to the auction to another party (such as a wireless carrier), the Commission could likewise permit the purchaser to cease operating the station and subsequently participate in the Spectrum Act auction.[266] Verizon likewise offered several constructive proposals, such as the Commission adopting a process for resolving disputes from negotiations over voluntary relocation by current Channel 51 broadcasters and offering incentives to Channel 51 broadcasters, such as "'first choice' among channels in the repacking process, and/or for those that participate in the incentive auction, a premium on their bids to sell."[267]

The Commission has ample authority under Title III to adopt flexible regulatory schemes such as this to reduce harmful interference.[268] The Commission further has broad authority to waive any existing rule that would otherwise require continued, full-power operation of a Channel 51 station as a condition to maintaining the operating license.[269] Such waiver is clearly appropriate here to eliminate sources of interference that are impeding efficient deployment and operation of next generation LTE services, while preserving the eligibility of current license

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[266] AT&T at 46. Such a transfer would clearly be in the "public interest" under Section 310(d) of the Communications Act as it would further the goals of the Spectrum Act and allow for immediate build out of LTE on Block A without the threat of Channel 51 interference.

[267] Verizon at 3.

[268] *See* 47 U.S.C. § 303(b) (Commission may "[p]rescribe the nature of the service to be rendered by each class of licensed stations and each station within any class"); *id.* § 303(f) (authorizing the Commission to "[m]ake such regulations not inconsistent with law as it may deem necessary to prevent interference between stations and to carry out the provisions of this chapter," including "changes in the frequencies . . . of any station" that are made with "the consent of the station licensee"); *id.* § 316(a)(1) ("[a]ny station license . . . may be modified by the Commission either for a limited time or for the duration of the term thereof, if in the judgment of the Commission such action will promote the public interest, convenience, and necessity, or the provisions of this chapter . . . will be more fully complied with").

[269] 47 C.F.R. § 1.3; *see also Ne. Cellular Tel. Co.* v. *FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990); *WAIT Radio* v. *FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969).

holders to participate in the Congressionally-authorized "reverse auction" for Channel 51 broadcast stations.[270]

Although Section 312(g) of the Communications Act may once have posed an obstacle by restricting the Commission's ability to allow a broadcast station to remain "dark" for more than 12 months, that is no longer the case. In the Satellite Home Viewer Extension and Reauthorization Act of 2004,[271] Congress amended Section 312(g) to allow the Commission to "extend or reinstate" – "for any ... reason to promote equity and fairness" – the broadcast license of any station that otherwise would lapse for failure to broadcast for a consecutive 12-month period.[272]

The Commission has recognized that this amended provision gives it "discretion" to waive Commission rules that would otherwise preclude a broadcast station from remaining "dark" for more than a year, including rules that would deem the broadcast license forfeited.[273]

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[270] AT&T at 47-48. In addition, as AT&T explained, under Section 6403 of the Spectrum Act, any "broadcast television licensee" that has "broadcast television spectrum usage rights" can participate in the reverse auction and the Commission could reasonably construe that a licensee that either continues to operate at lower power, moves to a different channel or temporarily ceases broadcasting prior to the auction continues to retain "broadcast television spectrum usage rights" in Channel 51. *See* AT&T at 46.

[271] The Satellite Home Viewer Extension and Reauthorization Act of 2004 was included as part of the Consolidated Appropriations Act of 2005, Pub. L. 108-447.

[272] *See In the Matter of Eagle Broadcasting Group, Ltd*, Memorandum Opinion and Order, 23 FCC Rcd. 588, ¶ 25 (2008) (recognizing that the automatic forfeiture provisions of section 312(g) do not apply where the Commission "prior to that time …. extends the license" under the amendments to section 312(g)).

[273] *See* Notice of Apparent Liability for Forfeiture and Order, *In the Matter of John L. White*, 24 FCC Rcd. 12541, ¶¶ 5-7 (2012) (Media Bureau); Memorandum Opinion and Order, *V.I. Stereo Communications Corp.*, 21 FCC Rcd. 14259, ¶¶7-8 (2006); *W230BH(FX)*, 2008 FCC LEXIS 7424, *8 (2008) (Media Bureau). While the cessation of broadcast operations will implicate Commission rules governing technical operation, *see* 47 C.F.R. §§ 73.614 (setting minimum and maximum power limits); 73.682 (setting forth transmission standards for television stations); 73.1740 (setting forth operating schedules for television stations), the Commission traditionally

As the courts have recognized, the term "'fairness and equity' is necessarily discretionary."[274] On at least four occasions, the Commission has applied its authority to "extend or reinstate" licenses under Section 312(g) to prevent the forfeiture of licenses for broadcasting stations where weather problems or local regulatory issues impaired the ability of a licensee to resume broadcasting.[275]

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has recognized explicitly or implicitly that authorization to remain dark also constitutes a waiver of these rules, *see, e.g.*, Notice of Apparent Liability for Forfeiture and Order, *John L. White*, 24 FCC Rcd. 12541, ¶¶ 5-7 (2012) (Media Bureau); Memorandum Opinion and Order, *V.I. Stereo Communications Corp.*, 21 FCC Rcd. 14259, ¶¶7-8 (2006); *W230BH(FX)*, 2008 FCC LEXIS 7424, *8 (2008) (Media Bureau). The Commission can and should also waive rules that do not expressly require operation of a broadcast station, but would impose unnecessary or unreasonable obligations in this context. *See* 47 C.F.R. §§ 73.673 (identification of children's programming to program guides); 73.1125 (main studio rule requirements); 73.1800-1840 (station log requirements); 73.1944 (governing "reasonable access" to Federal candidates for office); 73.2080 (EEO requirements); 73.3526 (public file maintenance requirements and filing of children's programming reports); 73.3615 (biennial filing of Ownership Reports). However, other rules maintained by the Commission governing broadcast operations do not require a waiver, because where broadcast operations are excused, violations of these content-based rules cannot occur. *See, e.g.*, 47 C.F.R. §§ 73.670 (limits on commercials in children's programming); 73.1201 (regular station identification required); 73.1212 (sponsorship identification requirements); 73.1941 (equal opportunities for political uses); 73.1942 (lowest unit rate requirements).

[274] *Masayesva* v. *Zah*, No. 93-15109, 1995 U.S. App. LEXIS 33710 at *30 (9th Cir. Sept. 11, 1995). For this reason, courts routinely defer to an agency's exercise of its discretion in weighing equities. *See, e.g.*, *Fla. Inst. of Technology* v. *FCC*, 953 F.2d 549, 554 (D.C. Cir. 1992); *Gillring Oil Co.* v. *FERC*, 566 F.2d 1323, 1326 (5th Cir. 1978); *S. Natural Gas Co.* v. *FERC*, 813 F.2d 364, 368 (11th Cir. 1987) (same).

[275] Notice of Apparent Liability for Forfeiture and Order, *In the Matter of John L. White*, , 24 FCC Rcd. 12541 (2009) (Media Bureau); *W230BH(FX)*, 2008 FCC LEXIS 7424 (2008) (Media Bureau); Petition for Reconsideration, *Chapman*, 22 FCC Rcd. 6578 (2007) (Media Bureau); Memorandum Opinion and Order, *In the Matter of V.I. Stereo Communications Corp.*, 21 FCC Rcd. 14259 (2006). Notably, the cases where the Commission has refused to "extend or reinstate" the license of a "dark" broadcasting station have almost invariably involved flagrant disregard for the Commission's rules. *See, e.g.*, *DWLMA (AM), Greenwood, SC Marradio, Inc.*, 27 FCC Rcd. 2925 (2009) (Media Bureau) (long history of non-compliance with the rules including operation of unauthorized facilities for more than fifteen years); *In the Matter of John L. White*, Notice of Apparent Liability for Forfeiture and Order, 24 FCC Rcd. 12541, ¶ 7 (2012) (Media Bureau) (noting prior cases in which the Commission refused to reinstate licenses under

Here, the case for Commission action is even more compelling, as strict application of Section 312(g) operating requirements threatens the Commission's important goals of providing new broadband services and increasing the value of public spectrum by eliminating sources of interference. The only way to fully eliminate existing Channel 51 interference while also allowing for full participation in the Spectrum Act auctions would be to allow Channel 51 licensees to cease broadcasting without the threat of loss of license. In contrast, it would be inequitable and unfair in the extreme to penalize Channel 51 licensees for acting to serve the public interest by eliminating existing interference caused by their broadcasts.[276]

E Block. There was likewise broad support for AT&T's position – including by several A Block licensees – that the Commission should impose conditions on DISH's operation of E Block spectrum similar to the conditions imposed on AT&T in the *Qualcomm* proceeding.[277] As AT&T explained, "[b]ringing uniformity to the Lower 700 MHz Block will eliminate interference from E Block that can degrade LTE service, and thereby further the public interest by creating regulatory certainty as to how that spectrum can be used, enhance the value of all of the spectrum in that block, and ultimately facilitate the deployment of next-generation broadband wireless services."[278] The need for such action is particularly acute given that DISH is currently

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section 312(g) involved instances where the licensee had made misrepresentations to the Commission).

[276] In addition, "[g]iven that there will likely be no broadcasting at all in this spectrum after the auctions," AT&T at 48, a temporary waiver of broadcasting-related requirements will not materially diminish the availability of broadcast TV stations.

[277] Cavalier at 14; Cricket at 11-12; CTIA at 6-8; King Street at 16; NTCA at 9; RIM at 14; T-Mobile at 18-19; U.S. Cellular at 19-20.

[278] AT&T at 49.

studying and testing high powered E Block broadcast video services and "plans to deploy a broadcast video service in the E Block."[279]

Contrary to DISH's claims, there is no policy-based or legal impediment to the Commission implementing this proposal.

DISH's primary argument, citing the Wireless Strategies report, is that there "is no evidence in the record showing that DISH's currently authorized power levels would cause harmful interference to devices operating in the Lower 700 MHz B and C Blocks."[280] The exact opposite is true. As explained above, the Wireless Strategies report itself shows that the (understated) E Block transmission levels it measured would result in interference in excess of 3GPP standards. In any event, as explained above, the Qualcomm study – which is based on actually measured power levels from Qualcomm's 50 kW MediaFlo service – clearly demonstrates that the high powered E Block transmissions will cause substantial interference to Band 12 devices, including those operating only in B and C Blocks.

In the alternative, DISH argues that any attempt to limit the power of its E Block transmissions "could foreclose use of the spectrum for broadcast services."[281] DISH offers no evidence for this conclusory assertion and, on close inspection of DISH's comments, it is clear that a lower power limit on E Block transmissions would not "foreclose" DISH's planned service, but, at most, make network buildout for that service more costly.[282] DISH, however, makes no attempt to quantify the magnitude of any such cost increases, let alone demonstrate that it would have a significant impact on the overall cost of deployment or the viability of

[279] DISH at 5, 8.

[280] *Id.* at 6.

[281] *Id.* at 8.

[282] *Id.* at 8-9.

DISH's planned service. Given the hard evidence demonstrating that E Block service contemplated by DISH will cause substantial interference for Band 12 devices (including those operating in the B and C Blocks), DISH's vague and conclusory claims provide no basis for the Commission to refrain from imposing reasonable power limits on E Block transmissions.

With respect to legal authority, DISH contends that new rules imposing the Qualcomm conditions on its E Block operations "may amount" to a partial revocation of its license, even though the "circumstances warranting revocation under Section 312 are not present."[283] DISH cites no authority for this proposition, and it is incorrect. Section 312 has no application here. It authorizes the Commission to "revoke" a license if the licensee violates various rules or statutes or commits other offenses. No party here is arguing that DISH's licenses should be *revoked* or that it has committed willful and repeated violations of the Commission's rules. At most, the parties are asking the Commission to "modify" DISH's licenses under Section 303(f), which expressly authorizes the Commission to modify licenses even over the objection of the licensee if the Commission finds that such modification would be in the public interest to prevent interference from affecting other licensees.[284] In the unique circumstances involving the potential for DISH's E Block operations to inflict debilitating interference on adjacent licensees, such an extraordinary modification under Section 303(f) would be justified.

[283] *Id.* at 9.

[284] Section 303(f) permits the Commission to make "regulations . . . as it may deem necessary to prevent interference between stations," and the section expressly permits the Commission to impose regulations "chang[ing] the . . . authorized power . . . of any station" without the "consent of the station licensee" if the Commission determines that "such changes will promote the public convenience or interest or will serve public necessity." 47 U.S.C. § 303(f); *see also id.* § 302a(a) & 303(e).

CONCLUSION

For the foregoing reasons, and for the reasons set forth in AT&T's initial comments, the Commission should not adopt an interoperability mandate but should instead expeditiously establish mechanisms to eliminate harmful interference from adjacent broadcasts.

Respectfully submitted,

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ATTACHMENT A

Supplemental Analysis: Impact of Channel 51 and E Block Interference on Band 12 and Band 17 User Equipment Receivers

Jeffrey H. Reed and Nishith D. Tripathi

Reed Engineering

EXECUTIVE SUMMARY

In our June 1, 2012 paper (submitted with the Comments of AT&T) we demonstrated that, as a matter of fundamental wireless engineering principles, Band 12 LTE devices and networks are far more susceptible to interference from Channel 51 and E block broadcasts than are Band 17 devices and networks. Band 12 is immediately adjacent to the frequencies allocated to high-powered Channel 51 TV and E block broadcast services, whereas Band 17 has significant separation from those high-powered transmissions. Consequently, the radio frequency ("RF") filters used in Band 12 devices provide far less attenuation of Channel 51 and E block transmissions than those used in Band 17 devices, which, in turn, means that Band 12 devices will experience much lower signal-to-interference ratios ("SIRs") – *i.e.,* the ratio of the desired signal power to interfering signals' power. Reduced SIR in this context means degraded device performance in the form of reduced data throughput and lost connections.[1]

The record before the Federal Communications Commission ("FCC") now contains extensive additional modeling, analysis, and testing, including the results of rigorous testing of how actual commercially available Band 12 and Band 17 filters and devices perform in the presence of Channel 51 and E block interference. These new data show, among other things that:

- commercially available Band 17 filters provide hundreds to tens of thousands of times more attenuation of Channel 51 and E block transmissions compared to the filters used in Band 12 devices;

- at Channel 51 signal levels estimated with FCC-approved signal propagation tools and E Block signal levels estimated from signal levels observed in actual commercial deployments in the D block, Band 12 devices operating in the Lower 700 MHz B and C blocks (but not Band 17 devices) would experience substantial interference from both Channel 51 and E block transmissions in very broad geographic areas – both within cells

[1] *See* Jeffrey H. Reed & Nishith D. Tripathi, *Impact of E block Interference on Band 12 and Band 17 User Equipment Receivers,* at 5-8, *attached to* Comments of AT&T Services Inc., WT Docket No. 12-69 (June 1, 2012), as Exhibit A ("Reed-Tripathi June 1, 2012 Paper").

and at cell edges – including in the core of major urban centers where mobile wireless broadband usage is most intensive; and

- as a consequence of this interference, consumers would experience not only significantly reduced device performance, but even a complete inability to obtain or maintain a connection to the LTE network.

Channel 51 Interference. As we previously explained,[2] for Channel 51, the potential interference is the result of "reverse intermodulation." The high-powered Channel 51 broadcasts enter Band 12 and Band 17 devices and interact with their uplink transmissions. This interaction results in reverse intermodulation, which creates new signals called "intermodulation products" that fall within the frequencies used by Band 12 and Band 17 devices to receive downlink signals, and thus interfere with the devices' ability to receive desired signals. Band 17 devices are necessarily subject to this type of interference to a much smaller degree compared to Band 12 devices because (1) Band 17 devices are better able to attenuate Channel 51 transmissions, which means that the interfering intermodulation products are much weaker in Band 17 devices and (2) the center of the intermodulation products fall largely within Band 12 frequency ranges and outside of Band 17 frequency ranges. Testing and analyses conducted by Qualcomm, Motorola, PCTEST, and 7Layers demonstrate that Channel 51 signal levels that likely would be experienced in the real world cause significant degradation in performance of Band 12 devices but have virtually no impact on the performance of Band 17 devices.

Qualcomm. Qualcomm conducted tests to estimate Channel 51 signal levels that cause intermodulation products sufficient to degrade the service of mobile devices. Qualcomm then examined the technical specifications of commercially available Band 12 and Band 17 RF filters, and showed that Band 17 filters – which offer 100 times more attenuation of Channel 51 signals than Band 12 filters – are able to attenuate these Channel 51 signals to levels below those that cause performance degradation, whereas Band 12 filters cannot. Moreover, Qualcomm showed, based on standard FCC-approved radio propagation tools and FCC data, that the Channel 51 signal levels which cause performance degradation and lost connections in Band 12 devices and networks (but not in Band 17 devices and networks), are likely to occur broadly, including in urban areas where usage is concentrated.

Motorola. Motorola conducted an analysis of the commercially available components used in Band 12 and Band 17 devices and reached the same conclusion as Qualcomm. Specifically, Motorola found that Band 12 devices are far less able to attenuate Channel 51 signals than Band 17 devices, and that, as a result, Band 12 devices will experience degradation of service in areas where Band 17 devices would experience no service degradation.

PCTEST and 7Layers. PCTEST and 7Layers, two well-regarded independent device testing firms, were engaged by AT&T to test the relative interference caused by Channel 51 transmissions in

[2] Reed-Tripathi June 1, 2012 Paper, at 9-13.

Band 12 and Band 17 devices. PCTEST and 7Layers each used a commercially available Band 12 device (offered by U.S. Cellular) in a controlled lab environment and followed well-accepted industry testing procedures to determine the Channel 51 signal levels at which the device begins to experience performance degradation. These tests show that the device began to experience throughput degradation and dropped calls at signal levels as low as –37 dBm, and that the device was unable to connect to the LTE radio network at all at Channel 51 signal levels above -24 dBm. An otherwise identical Band 17 device experienced no significant performance degradation at any of the measured Channel 51 signal levels.

E block Interference*.* High-powered 50 kW E block transmissions cause adjacent channel interference ("ACI").[3] Although Band 12 and Band 17 devices have receive filters designed to attenuate signals outside the desired frequency range, no filter can fully attenuate signals that are relatively close to the RF filter's "passband" frequency. Rather, RF filters experience "roll-off," which means that signals immediately adjacent to the passband are less attenuated than signals further from the passband frequency. Because the E block signals are in the frequency range that is immediately adjacent to the lower passband frequency used in Band 12 devices, significant power from E block signals passes through a Band 12 device's receive RF filter and causes interference. By contrast, the frequency range used by Band 17 devices has 6 MHz of separation from E block signals, and therefore the RF filters in Band 17 devices are much better able to attenuate E block signals, resulting in less interference. Accordingly, Band 17 devices and networks are far less susceptible to E block interference than Band 12 devices and networks.

Qualcomm confirmed these facts. Qualcomm demonstrates that, according to 3GPP standards, LTE devices operating in the presence of E block signals above -56 dBm will begin to experience degradation, and that, according to commercially available RF filter specifications, Band 12 RF filters are able to attenuate E block signals by only 7 dB. Band 12 LTE devices will thus begin to experience performance degradation in the presence of pre-filtered E block signal levels above about -48 dBm. By contrast, Band 17 RF filters provide 49 dB attenuation of E block transmissions, and thus will not experience performance degradation unless E block signal levels reach about -6 dBm (an extremely high signal level that is unlikely to occur in real world deployments).

Furthermore, Qualcomm is well situated to determine the extent to which a commercially deployed E block network will produce signal levels between -49 dBm and -6 dBm because it is a former operator of a 50 kW D block network, and D block transmissions and E block transmissions have nearly identical propagation characteristics. Qualcomm has submitted real-world D block signal levels it obtained from drive tests of its commercially deployed networks for Dallas/Fort Worth and Phoenix. These measurements show that in large portions of these cities, D block signals were well above -49 dBm, but below -6 dBm, confirming that a similar E

[3] Reed-Tripathi, June 1, 2012 Paper, at 13-16.

block network would cause significant degradation in performance for Band 12 devices and networks, but not for Band 17 devices and networks.

Impact of Channel 51 and E block Interference. These test and analyses confirm that in broad geographic areas, including in major urban centers where usage is concentrated, Band 12 devices (but not Band 17 devices) will be unable to obtain or maintain connections to an LTE network, or will experience significant degradation in throughput and quality of service. For example, the FCC-approved Longley-Rice broadcast signal propagation tool shows that large portions of Kansas City, MO, Chicago, IL, and Providence, RI have Channel 51 signal levels that the PCTEST and 7Layers testing demonstrates would degraded service in Band 12, but not Band 17, devices. AT&T usage data confirm that about 70 or more percent of busy hour data usage is concentrated in these areas. Similarly, Qualcomm shows that in large portions of Dallas/Fort Worth, its MediaFLO service had signal levels above -49 dBm that would cause performance degradation in Band 12 devices, but not Band 17, devices, and AT&T usage data indicate that about 28 percent of its Dallas/Fort Worth busy hour data usage is concentrated in these areas.

Wireless Strategies' And V-COMM's Flawed Analyses. In our initial paper, we responded to a 76 page report that was submitted by Wireless Strategies just a few days before our paper was due to be filed with the FCC. Based on our initial analysis of that report, we showed that the testing and analyses it presented are fundamentally flawed. We have now had time to more thoroughly examine that report, and we have further confirmed our initial findings and have identified additional problems. *Most significantly, Wireless Strategies never actually tested whether a Band 12 device would perform better or worse than a Band 17 device in the presence of Channel 51 or E block interference.* It did not test any Band 12 devices, and worse, Wireless Strategies purposely ignored the differences in the RF filters used in Band 17 and Band 12 devices that are the main determinants of a device's ability to perform in the presence of interfering signals. Instead, Wireless Strategies purports to have evaluated only whether Band 12 devices are likely to work at all in the presence of Channel 51 and E block interference. But whether a device will work at all is not the issue; the issue is relative performance of Band 12 and Band 17 devices. In any case, as we explain below, Wireless Strategies' analyses of whether a Band 12 device is likely to work are flawed, as confirmed by the tests of actual Band 12 devices by PCTEST and 7Layers.

One business day before the submission date for this supplemental report, V-COMM, L.L.C. ("V-COMM") submitted a report purporting to analyze the relative impact of Channel 51 and E block signals on Band 12 and Band 17 devices. Although we have not yet had time to thoroughly review the V-COMM report, it appears to include significant errors and omissions. As we describe further below, for example, the highlight of the report is V-COMM's "testing on a live commercial network" in Waterloo, Iowa that US Cellular reconfigured to operate in the B and C Blocks on Band 12. V-COMM claims that its drive-testing of the reconfigured network is proof that Channel 51 poses no threat to Band 12 operation in the B and C Blocks. In fact, V-COMM's Waterloo "test" looks for interference in the wrong places. The nearest Channel 51 broadcast tower to Waterloo is in Cedar Rapids, *nearly 60 miles away*. It is predictable, therefore, that V-COMM's own modeling shows that the Channel 51 signal levels in and around

Waterloo are well below the thresholds that Qualcomm, PCTest, and 7Layers have shown would trigger performance-degrading interference. V-COMM's Channel 51 and E Block lab test results are also flawed, and omit critical information needed to evaluate them. Among other failings, V-COMM fails to disclose the LTE signal levels it used to obtain results that are so irreconcilable with all of the other testing and analyses in the record.

1. MEASURES OF AND HARMS FROM INTERFERENCE

We demonstrated in our initial paper that one of the most important factors affecting the performance of wireless networks and devices – that is, the efficiency and speed at which devices can receive and send transmissions – is the SIR.[4] When this ratio falls – *i.e.* the strength of the interfering signals increases relative to the desired signal – device and network performance fall as well. Another measure often used by wireless engineers to measure the impact of interference is "desensitization."[5] Desensitization refers to the reduction in the ability of the receiver to detect the desired signal. A receiver can detect the desired signal when it is above the overall noise floor, *i.e.,* the sum of the thermal noise floor and interference. Higher interference therefore raises the overall noise floor, making it more difficult for a device to detect the desired signal. The level of desensitization can be quantified as the difference between (i) the combined interference and thermal noise and (ii) the thermal noise.[6] The greater the desensitization levels, the worse the device and network performance.[7]

As we explained in our initial paper, the impact of decreased SIRs and increased desensitization levels includes, among other things, reduced throughput, smaller effective cell sizes and reduced coverage. Moreover, when SIRs are low enough, or where desensitization levels are high enough, devices will be unable to obtain or maintain connections to the network, resulting in interrupted service or no service at all.

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[4] Reed-Tripathi, June 1, 2012 Paper, at 9-13.

[5] Comments of Qualcomm Incorporated, In the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum and Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69 and RM-11592 (Terminated), at 37 (June 1, 2012) ("Qualcomm").

[6] For example, if the thermal noise floor including the effect of the receiver noise figure is -101.47 dBm (or 7.13×10^{-11} mW) and the interference is -90 dBm (or 10^{-9} mW), the total noise plus interference is $(7.13 \times 10^{-11} + 10^{-9}) = 1.07 \times 10^{-9}$ mW or -89.70 dBm. The level of desensitization is then (-89.70 dBm) – (-101.47 dBm) = 11.77 dB.

[7] Desensitization is directly related to SIR levels. At a given desired signal level, increasing the overall noise (*i.e.*, combined thermal noise and interference) by 3 dB increases desensitization, and the SIR experienced by the receiver decreases by 3 dB.

In addition, increased interference can cause significant degradation in ways that are unique to LTE systems. Most notably, LTE systems are capable of using multiple modulation schemes.[8] A low order QPSK (Quadrature Phase Shifting Keying) modulation scheme is relatively resistant to interference, but it is the least efficient from the perspective of data throughput. The high order 16-QAM (16-Quadrature Amplitude Modulation) and 64-QAM modulation schemes are far more efficient than QPSK, and provide far greater throughput. In general, 64-QAM yields three times the throughput of QPSK and 16-QAM yields twice the throughput of QPSK. However, 64-QAM and 16-QAM are far more sensitive to interference levels. Modern LTE networks choose the modulation scheme in real time based on SIRs.[9] When SIRs are high enough, the LTE base station (*i.e.,* the "eNodeB") will use the most efficient 64-QAM modulation scheme. But when SIRs are lower for a given device, the eNodeB shifts to a 16-QAM modulation scheme or, as SIRs continue to decrease, to a QPSK modulation scheme. Thus, increasing interference in any particular area will generally shrink the areas where the network can take advantage of higher order modulation schemes, thus resulting in significant loss in throughput for customers located in areas where, absent the additional interference, they would have been able to use more efficient high order modulation schemes.

2. THE RELATIVE IMPACT OF CHANNEL 51 AND E BLOCK INTERFERENCE ON BAND 12 AND BAND 17 DEVICES

We explained in our initial paper that, as a matter of fundamental physics and electrical engineering principles, mobile devices configured with Band 12 are more susceptible to interference from Channel 51 and E block broadcasts than mobile devices configured with Band 17. Because Band 12 devices are more susceptible to such interference, Band 12 devices are more likely to experience lost connections and reduced throughput compared to Band 17 devices. We further explained that this interference cannot be easily mitigated, and can never be completely eliminated.[10] Testing and analyses by multiple independent third parties confirm our analytical findings, and show significantly more degradation in the performance of Band 12 devices and networks compared to Band 17 devices and networks under real-world conditions.

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[8] A modulation scheme enables the transmitter to represent the information bit stream (*i.e.*, binary 1s and 0s) in the form of modulation symbols. For example, one modulation symbol may represent two bits in the case of one modulation scheme and six bits in case of another modulation scheme. The modulation scheme plays an important role in determining the achievable throughput. In LTE, the modulation scheme can be changed for a given device as fast as every millisecond.

[9] The device quantifies the downlink channel conditions in the form of Channel Quality Indicators ("CQIs") that are a function of the SIRs experienced by the device. The device reports such CQIs to the eNodeBs, and, the eNodeBs use the reported CQIs to determine various transmission parameters including the modulation scheme.

[10] Reed-Tripathi, June 1, 2012 Paper, at 5-13, 16-23.

2.1. Channel 51 Interference

The harmful interference from Channel 51 broadcasts affecting the relative performance of Band 12 and Band 17 devices arises from "reverse intermodulation." Channel 51 licensees are authorized to transmit at power levels up to 1 MW. The frequencies used by Channel 51 are immediately adjacent to the uplink frequencies used by Band 12. Channel 51 signals therefore enter Band 12 (and, to a much lesser extent, Band 17) devices and interact with devices' uplink transmissions. This interaction results in reverse intermodulation, which creates new signals called "intermodulation products." The frequency ranges in which the intermodulation products occur can be readily calculated using standard wireless engineering formulae. Based on these formulae, for a service provider that is operating either only in the C block or in both the B and C blocks,[11] these intermodulation products occur within and immediately adjacent to the *receive* frequencies used by Band 12 devices, but to a far lesser extent for Band 17 devices.[12]

Analyses and testing independently conducted by Qualcomm, PCTEST and 7Layers confirm that Band 12 devices experience significantly more throughput degradation than Band 17 devices at Channel 51 signal levels, and will even cease to be able to obtain or maintain connections in many areas, including urban areas where data usage is concentrated.

A. The Qualcomm Analyses And Testing. Qualcomm analyzed the specifications of filters used in commercially available Band 12 and Band 17 devices. According to these specifications, a "Band 12 filter provides approximately 5 dB rejection of Channel 51, compared to approximately 25 dB rejection of Channel 51 by the Band 17 filter."[13] It is therefore clear from the outset that Band 12 devices will be subject to greater reverse intermodulation interference than Band 17 devices because harmful reverse intermodulation product increases with Channel 51 signal levels and Band 12 filters provide much less attenuation of Channel 51 signal levels than Band 17 filters.

To quantify this difference in performance for Band 12 and Band 17 devices, Qualcomm computed the Channel 51 signal levels that would result in harmful interference to an LTE device. Given the dearth of technical or scholarly studies providing empirical data on the

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[11] AT&T operates its lower 700 MHz LTE network in some markets in the B block only, in others in the C block only, and in still others in the combined B & C blocks.

[12] As discussed further below, while the frequency ranges in which intermodulation products fall can be easily calculated, no standard formula exists for determining the strengths of those products.

[13] Qualcomm, at 35.

measurements of reverse intermodulation or accepted formulae for predicting it,[14] Qualcomm conducted lab tests, using readily available equipment. Qualcomm used a digital television waveform at 1954 MHz (to mimic Channel 51 signal) and a UMTS waveform at 1930 MHz as the device's transmit signal (to mimic an LTE transmit signal), and a Triquint TQM776011 power amplifier (a power amplifier typically used in mobile devices). Using these pieces of equipment, Qualcomm was able to estimate the amount by which devices using C block only or the B and C blocks in the uplink would experience desensitization as a function of increasing Channel 51 signal levels and amplifier gain states.[15] Qualcomm found that interference can begin to occur at Channel 51 signal levels of about -30 dBm.[16] In fact, as testing by PCTEST and 7Layers show (discussed below), performance-degrading harmful interference can begin at even lower Channel 51 signal levels (7Layers, for example, measured throughput degradation at Channel 51 signal levels as low as -37 dBm). Thus, Qualcomm's coverage analysis showing large sections of interference prone areas likely understates the impact.

Qualcomm next used FCC-approved propagation modeling tools and data to estimate where Channel 51 signal levels likely exceed -30 dBm. Qualcomm used the FCC-recommended Longley-Rice propagation model, a popular propagation tool called CRC Radio Coverage Prediction Tool, and Channel 51 transmitter location-specific information from the FCC database, to measure Channel 51 signal strengths for Kansas City, Missouri, Montclair, NJ, Providence, Rhode Island, and Chicago, Illinois. Qualcomm verified the propagation results with the FCC's DTV Reception Maps tool. These analyses show that Channel 51 signal levels in large portions of these areas, including downtown urban centers and congested commuting routes, have Channel 51 signal levels above -30 dBm.[17]

In short, Qualcomm's analyses demonstrate that Band 12 devices will be subject to significant desensitization in urban centers and commuter routes that cause "capacity [to] degrad[e]," "cell sizes . . . to shrink," "los[t] service," and ultimately "*de facto* exclusion zones near Channel 51 transmitters."[18]

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[14] *See* Qualcomm, at 36. *See also* Allen Katz *et al.*, *Sensitivity and Mitigation of Reverse IMD in Power Amplifiers,* at 53 (2011 IEEE Topical Conference on Power Amplifiers for Wireless & Radio Applications (PAWR), No. 10.1109/PAWR.2011.5725374 (2011)).

[15] Qualcomm, at 37-39.

[16] *See,* Qualcomm, at 45 ("because these power levels are predictive of interference and substantial fluctuations will occur during actual operation, consumers may experience interference even in the borderline -20 to -30 dBm areas.").

[17] Qualcomm, at 46.

[18] Qualcomm, at 43-55.

B. The Motorola Analysis. Motorola also "studied the impact of receiver desensitization when operating in the presence of a high powered television transmitter operating on TV Channel 51."[19] Motorola concluded that "[w]ith existing commercially available components . . . Band 12 devices will suffer reduced sensitivity when they are within 2.2 kilometers . . . to 10.9 kilometers . . . of a Channel 51 transmitter," and will affect Band 17 devices only when operating much closer to the Channel 51 transmitter.[20] Thus, Motorola's analysis provides further confirmation that Band 12 devices are more susceptible to Channel 51 reverse intermodulation interference than Band 17 devices.

C. The PCTEST and 7Layers Analyses. AT&T engaged PCTEST and 7Layers, two independent and well-regarded mobile wireless testing firms, to test whether Channel 51 transmissions cause degradation in performance of commercially available Band 12 and Band 17 devices. Thus, unlike Wireless Strategies' tests, PCTEST and 7Layers analyzed the relative throughput of actual commercially available Band 12 and Band 17 devices. The Band 12 device tested by PCTEST and 7Layers is a tablet offered by U.S. Cellular, and the Band 17 device tested by PCTEST is a version of the same tablet offered by AT&T.[21] We have reviewed the reports submitted by PCTEST and 7Layers showing the methods and results of their testing, and we have discussed these reports with engineers from PCTEST and 7Layers. We have attached those reports to this paper. In particular Exhibit A describes the methodology used by PCTEST and 7Layers, and Exhibits B and C contain the results of these tests for PCTEST and 7Layers, respectively. We find these tests to be well designed and reliable.

The results of the testing conducted by PCTEST and 7Layers confirm that Band 12 devices are far more susceptible to interference from Channel 51 broadcasts than are Band 17 devices. As discussed below, these tests show that Band 12 devices experience degradation in throughput in the presence of Channel 51 signal levels as low as -37 dBm, and that throughput for Band 12 devices declines precipitously as Channel 51 signals increase above the level at which throughput begins to decline. At Channel 51 signal levels of -30 dBm, for example, one 7Layers test indicates that throughput for Band 12 devices is cut nearly in half. In addition, these tests indicate that Band 12 devices can drop the LTE radio connection at Channel 51 signal levels above -27 dBm, and that Band 12 devices may be unable to access the LTE network at all at Channel 51 levels greater than -24 dBm.

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[19] Comments of Motorola, In the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum and Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69 and RM-11592 (Terminated), at 2 (June 1, 2012) ("Motorola").

[20] Motorola, at 3.

[21] We have confirmed that the filters used in these devices are from Epcos, and that, consistent with Qualcomm's findings, these Band 12 filters offer only about 5 dB attenuation of Band 51 signals, whereas the Band 17 filters offer over 30 dBm attenuation of Band 51 signals.

The tests conducted by PCTEST and 7Layers follow the guidelines specified by 3GPP for testing the performance of LTE devices to ensure that they meet 3GPP standards. To evaluate the impact of Channel 51 reverse intermodulation interference, these tests analyzed the performance of the test devices when transmitting in the C block and receiving in the B and C blocks. The testing was conducted in a controlled lab environment using Rhode & Schwarz ("R&S") equipment, which is widely used in the industry to evaluate the performance of mobile devices. The same test conditions were used for both the Band 12 and Band 17 LTE devices. The test configurations included two Rhode & Schwarz signal generators connected to the LTE devices. These signal generators created a Channel 51 signal and a downlink 10 MHz LTE signal in the B and C blocks. PCTEST and 7Layers used a device transmit signal of 23 dBm.[22]

Pursuant to the 3GPP testing procedures, baseline reference sensitivity for each of the mobile devices was measured and the downlink signal level was then assumed to be 3 dB above the reference sensitivity. This LTE signal was used to measure the reference "100%" throughput level for the devices. Any degradation in throughput as a result of interference would reduce the throughput to a level below this 100% throughput level.

To measure the degradation caused by Channel 51 interference, a center carrier frequency for the downlink LTE channel was set to 741 MHz and the center carrier frequency for the uplink LTE channel was set to 711 MHz. The power level of the Channel 51 signal at the device receive antenna was varied from -50 dBm to -20 dBm.

PCTEST tests allocated all 50 physical resource blocks ("PRBs") available in the network for the downlink for its tests.[23] The assumption that the device would be allocated all 50 physical resource blocks understates the extent to which Band 12 devices will experience significant performance degradation relative to Band 17 devices. When a device is allocated 50 PRBs, it is less susceptible to interference because resource blocks that are less subject to interference (those further away from the center frequency of the intermodulation product) would facilitate the correct retrieval of the downlink packet. But, in the real world, far fewer than 50 PRBs are typically allocated to a given device, and several devices would be allocated those few resource blocks where interference is strongest. In such cases, these devices will be less able to avoid interference. Thus, testing the impact of Channel 51 interference, where the device is allocated all 50 available PRBs in the 10 MHz bandwidth, understates the potential for interference.

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[22] This transmit power level corresponds to the maximum transmit power of a Power Class 3 mobile device defined by the 3GPP.

[23] There are 50 available PRBs within a 10 MHz block of spectrum. A device is allocated one or more PRBs dynamically (as fast as every millisecond) by the eNodeB for uplink and downlink transmissions, depending on various factors, including, for example, the amount and priority of data waiting in the buffer of each device in the cell, the Quality of Service needed for the data transmission for each device in the cell, prevailing uplink channel conditions, and the available PRBs.

As shown in the PCTEST report, notwithstanding the use of all 50 downlink PRBs, the tests show that the Band 12 device used in the test experienced throughput degradation at Channel 51 signal levels as low as -34 dBm, and that throughput declined rapidly as the Channel 51 signal level increased. At Channel 51 signal levels of about -27 dBm, the Band 12 device experienced radio link failure (often referred to as a call drop or connection drop), which would significantly reduce throughput and lead to poor user experience as the device reestablished the connection to the LTE network.

The tests described above were conducted using the R&S automated testing procedures. The R&S platform used by PCTEST was configured to automatically end testing when the performance of the device drops below 3GPP specifications. PCTEST also sought to determine the signal levels where the Band 12 device could no longer connect to the LTE network. To conduct these tests, PCTEST used the R&S equipment in manual mode, as described in the attached PCTEST report. These tests show that the Band 12 device was unable to access the LTE radio network in the presence of Channel 51 signal levels of about -24 dBm or greater. That is, the Band 12 device was unable to connect to the LTE network at all, leading to an access failure.

The independent tests conducted by 7Layers likewise confirm that the Band 12 device experienced significant degradation in throughput and radio link failures in the presence of Channel 51 signals. 7Layers conducted two tests using the R&S equipment to quantify the performance of Band 12 devices in the presence of Channel 51 transmissions. In the first test, 7Layers measured the throughput of a Band 12 device using all 50 available PRBs for the downlink, and in the second test, 7Layers quantified the performance of the Band 12 device using 16 PRBs for the downlink. As shown in the attached test report from 7Layers, these tests confirm that Band 12 devices experience significant degradation in throughput in the presence of Channel 51 transmissions as low as -37 dBm; that throughput quickly declines as Channel 51 signals increase; that this throughput degradation is greater when the device is assigned 16 PRBs rather than 50 PRBs.

Indeed, as explained in the 7 Layer's test report, its test results include multiple power cycles, because the interfering signal caused the LTE radio link to drop. When that occurred, it was necessary to turn off the Channel 51 interferer (*i.e.,* eliminating Channel 51 interference) and to restart the device to allow it to reconnect to the LTE radio network. After the device re-established its LTE radio connection, the Channel 51 interferer was turned on at the level at which the LTE radio link had dropped and the tests continued. This process was repeated each time the LTE radio link was lost until the throughput measurements were obtained for the target Channel 51 signal level in the test.

These 7Layers tests thus confirm that Band 12 devices are subject to significant throughput degradation and radio link failures in the presence of Channel 51 signal levels; the throughput degradation by more than 5% (i.e., below the 95% 3GPP test threshold for reference sensitivity) starts for Channel 51 levels as weak as around -37 dBm in the 16 PRB scenario. And, as Qualcomm demonstrated using the FCC-approved Longley-Rice propagation modeling and FCC data, Channel 51 signal levels will often exceed -30 dBm in large urban centers and commuter routes.

By contrast, PCTEST confirmed that Band 17 devices experience no significant throughput degradation at the measured Channel 51 signal levels. The Band 17 device tested by PCTEST was a Band 17 version of the Band 12 device used in the PCTEST and 7Layers tests described above. PCTEST tested the performance of the Band 17 device using the identical equipment and methods it used to test Band 12 device, and found no degradation in performance for Band 17 devices.

The analyses conducted by Qualcomm, PCTEST, and 7Layers likely significantly understate the extent to which Band 12 devices will experience significant performance degradation relative to Band 17 device for multiple reasons. First, as explained above, in the real world far fewer than 50 PRBs (or even 16 PRBs) will typically be allocated to a device, as the 7Layers testing confirms, reducing the number of PRBs causes performance degradation to occur at lower Channel 51 signal levels. Second, these tests do not account for throughput degradation caused by a device being forced to use lower-order modulation schemes, such as QPSK, when in the presence of interference cause by Channel 51 transmissions.[24] Third, real-world noise levels often will be above those experienced in the controlled lab experiments, which will mean that Band 12 devices will experience performance degradation at much lower additional interference levels caused by Channel 51 transmissions.

The analyses conducted by Qualcomm, PCTEST, and 7Layers likely understate the true impact of Channel 51 interference in other respects as well. For example, the FCC-approved propagation analyses conducted by Qualcomm focus on *average* signal levels, not maximum signal level likelihoods. In practice, the actual area adversely affected by Channel 51 interference could be much larger than the area predicted by a -30 dBm contour shown by the Longley-Rice propagation tool. Consider a location outside the -30 dBm contour where the *average* Channel 51 signal strength is -35 dBm. While the average Channel 51 signal level may be -35 dBm, propagation effects such as shadow fading and multipaths can easily lead to instantaneous Channel 51 signal strength of -30 dBm or greater. Shadow fading is often modeled by a log-normal distribution, the standard deviation of which could be 8 dB to 14 dB depending upon

[24] As discussed above, in Section 1, good channel conditions enable the use of a high-order modulation scheme (*e.g.*, 16-Quadrature Amplitude Modulation (16-QAM) or 64-QAM) and little channel coding (*i.e.*, minimal redundancy), leading to higher throughput. In contrast, poor channel conditions resulting from weak desired signal and/or high interference necessitate the use of a low-order modulation scheme (*e.g.*, Quadrature Phase Shift Keying (QPSK)) and heavy channel coding (*i.e.*, significant redundancy), leading to lower throughput. The tests use QPSK modulation for both downlink and uplink transmissions. In practice, Channel 51 interference will reduce the cell area where high throughput can be achieved, because high interference will cause degradation in SIR and will reduce the area where high-order modulation scheme and little coding can be exploited.

the environment. Given the magnitude of the standard deviation, a location with an average Channel 51 signal strength of -35 dBm could frequently experience an instantaneous Channel 51 signal strength exceeding -30 dBm.[25] Similarly, multipath in an urban environment may lead to coherent combining of the Channel 51 signals at the receiver, leading to increased interference levels exceeding -30 dBm even though the average strength is significantly lower.

2.2 E Block Interference

We demonstrated in our initial paper that Band 12 devices are far more susceptible to harmful interference from E block broadcasts than Band 17 devices.[26] The potential interference from E block transmissions is caused by the ACI. E block transmissions occur in frequency ranges almost immediately adjacent to the Band 12 downlink frequencies. Although all Band 12 and Band 17 mobile devices have receive filters designed to attenuate signals outside the desired frequency range, no filter can attenuate completely signals that are relatively close to the "passband" frequency. Rather, radio filters experience "roll-off," which means that signals immediately adjacent to the passband are less attenuated than signals further from the passband frequency. The FCC has authorized high-powered transmissions in the E block, and because the E block frequency range is quite close to the lower passband frequency used in Band 12 devices,[27] significant power from E block signals will pass through a Band 12 device's receive RF filter and cause interference. By contrast, the frequency range used by Band 17 devices have 6 MHz of separation from E block signals, and therefore the RF filters in Band 17 devices are better able to attenuate E block signals, resulting in less interference.

Qualcomm confirms this analysis with its own analyses and testing. Qualcomm shows that there is a real risk that signal levels that can be expected in a real world E block deployment will cause sufficient interference in Band 12 devices to degrade performance. Qualcomm shows that the relevant "3GPP requirements specify that a receiver in a consumer device will operate properly in the presence of: (1) a -52 dBm (5 MHz bandwidth) signal ±5 MHz from the channel center; (2) a -56 dBm (5 MHz bandwidth) signal at ±10 MHz from the channel center; or (3) a -44 dBm (5 MHz bandwidth) signal at >= 15 MHz from the channel center."[28] Based on these 3GPP requirements, Qualcomm shows that a service provider operating in the B block, the center of which is 12 MHz away from the center of the E block broadcast, can suffer harmful

[25] For example, the probability of 5 dB variation above the average signal strength (*i.e.*, -30 dBm instantaneous signal strength instead of -35 dBm average strength) is 25% in the case of an 8 dB standard deviation.

[26] Reed-Tripathi, June 1, 2012 Paper, at 13-16.

[27] There is only 1 MHz separation between the E block and Band 12.

[28] Qualcomm, at 7-8

interference – that is interference that exceeds permissible 3GPP specifications – when E block signals are at levels of -56 dBm or greater.[29]

Thus, E block transmissions as low as -55 dBm (*i.e.*, one dB greater than the maximum -56 dBm 3GPP threshold) that reach the receiver of a Band 12 handset or a Band 17 handset operating in B block will cause the device to operate below minimum 3GPP standards. The next question is the extent to which commercial Band 12 and Band 17 filters can attenuate the E block transmissions to the levels below -56 dBm. To address this question, Qualcomm examined the specifications of commercially available Band 12 and Band 17 filters. According to these specifications, a Band 12 filter "provides 7 dB of E block rejection, while a Band 17 filter provides 49 dBm of E block rejection."[30] That is, Band 17 filters provide "15,849 times more attenuation" of E block signals than Band 12 filters.[31] From these data, it is relatively straightforward to estimate the E block signal levels that will pass through Band 12 and Band 17 filters and impact a device's receiver.

For example, if a Band 12 device encounters an E block signal as weak as just above -49 dBm, its filter will be unable to attenuate that signal to -56 dBm. This means that any Band 12 device operating in the B block will experience interference that is above the maximum levels set forth in the 3GPP LTE specification (-56 dBm) when the E block signal is -49 dBm or stronger.[32] By contrast a Band 17 device will operate comfortably within 3GPP specifications with signal level of -49 dBm, because the Band 17 device providers much greater attenuation. A Band 17 device, for example, will be able to attenuate a -49 dBm E block signal to -98 dBm, far below 3GPP thresholds.

Qualcomm also demonstrates the impact of the E block interference from a desensitization perspective. When a device experiences 3 dB or greater desensitization caused by an interfering signal, interference "becomes the dominant performance concern, undermining the device's operations, rendering the device unable to receive a signal at the edges of cellular coverage areas and in many indoor environments."[33] When interference reaches levels that cause 6 dB or more desensitization, it "doubles the negative impact on the device, more severely shrinking the coverage areas of cells and resulting in dropped calls, service

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[29] Qualcomm, at 8.

[30] Qualcomm at 9.

[31] Qualcomm, at 9.

[32] Qualcomm, at 8-9.

[33] Qualcomm at 12.

interruptions, and lost system capacity."[34] These are well known impacts of interference in cellular communications.[35]

Given the performance of available filters, a -50 dBm E block signal at the device antenna translates into a 3.81 dB of desensitization for a Band 12 device.[36] As Qualcomm correctly computes, desensitization levels rise very quickly with increasing E block signal levels.[37] A -40 dBm E block signal at the device antenna will produce 11.8 dB desensitization for a Band 12 device, resulting in severe device performance problems, including dropped calls and lost system capacity.[38] By contrast, the significantly greater attenuation provided by Band 17 filters essentially avoids desensitization.[39]

The next question is the extent to which E block levels above -50 dBm are likely to exist in the real world. As we explained in our initial paper, one of the significant challenges to ascertaining and quantifying the real world impact of E block interference is that there are no real-world commercial E block deployments operating today. Qualcomm, however, has the advantage of having formerly operated a D block network, called MediaFLO, which, like the E block, was authorized to transmit at 50 kW. The D block spectrum has nearly identical propagation and path loss characteristics to the E block spectrum.[40] When MediaFLO was operational, Qualcomm conducted drive tests of its network, which confirm that that real world D block signal levels from Qualcomm's commercially deployed D block network in two sample cities (Dallas/Fort Worth and Phoenix) were well above -48 dBm in highly populated downtown areas and along commuter highway routes.[41] As shown above, E block transmissions at these levels would cause significant degradation in performance for Band 12 devices, but not for Band 17 devices.

Qualcomm also correctly points out that E block transmissions may also interfere with devices through intermodulation. Although our original paper and the FCC's *Notice* focus on the ACI caused by the E block transmissions, it is also true, as Qualcomm points out, that E block

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[34] Qualcomm at 12.

[35] Nishith Tripathi and Jeffrey Reed, "Cellular Communications: A Comprehensive and Practical Guide," To be Published by IEEE/Wiley, 2012.

[36] Qualcomm, at 11.

[37] Qualcomm, at 11-12.

[38] Qualcomm, at 11-12.

[39] Qualcomm, at 11-12.

[40] Qualcomm, at 14-17.

[41] Qualcomm, at 28.

transmissions will cause intermodulation interference. Mobile device receivers contain nonlinear components that lead to the creation of intermodulation products. For example, a mixer in the receive chain is used to down-convert the RF signal to the baseband signal for further processing by other receiver components such as the baseband chipset. The mixer is a nonlinear device and can generate intermodulation products when two RF signals combine with each other.[42] In particular, a strong E block signal and the device's own transmit signal can enter the mixer in the receive portion of the transceiver and create a harmful third order intermodulation product. This intermodulation product can then reduce the sensitivity of the receiver and cause problems such as low throughput and even a dropped call. A Band 12 device cannot significantly attenuate the received E block signal due to a mere 1 MHz separation, but a Band 17 device can significantly attenuate the E block signal. A stronger E block signal entering the mixer would generate a stronger third order intermodulation product in a Band 12 device, degrading the performance. In contrast, a much weaker E block signal will enter the mixer of a Band 17 receiver, significantly reducing the likelihood of performance degradation.[43]

Qualcomm shows that if a Band 12 "device operating on either B or C Block experiences an E block power of -31.4 dBm or greater, it will experience … desensitization of 3 dB or greater due to harmful intermodulation interference."[44] Desensitization of 3 dB or greater occurs due to the E block intermodulation interference for the combined B and C block reception when the E block signal level is -34.5 dBm or greater.[45] In contrast, when the E block signal arrives at the

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[42] Agilent, "The Use of Intermodulation Tables (IMT) for Mixer Simulation," http://cp.literature.agilent.com/litweb/pdf/5989-9470EN.pdf; Radha Setty, Daxiong Ji and Harvey Kaylie, "Figure of Merit of Mixer Intermod Performance," AN-00-001, http://www.minicircuits.com/app/AN00-001.pdf.

[43] A numerical example illustrates this point. An E block signal centered at 725 MHz and the B block uplink signal centered at 707 MHz leads to the third order intermodulation product centered at 743 MHz (i.e., 2*(725)-707), which is the center of the C block downlink. This intermodulation product occupies the frequency range 734.5 MHz to 751.5 MHz, which includes the B block downlink (i.e., 734 MHz to 740 MHz), causing interference to the B block reception. This intermodulation product, once generated in the receive portion of the transceiver, cannot be mitigated by the receiver. However, the interference level of this product is influenced by the level of the E block signal entering the mixer through the duplexer's RF filter. Since a Band 12 receive RF filter in the duplexer cannot attenuate the E block signal significantly due to only 1 MHz separation between Band 12 and the E block, in contrast to a Band 17 receive filter that benefits from 6 MHz separation between Band 17 and the E block, the intermodulation product is much stronger for a Band 12 device, leading to performance degradation.

[44] Qualcomm, at 23.

[45] Qualcomm, at 23.

receive antenna at the level of -30 dBm, the Band 17 filter attenuates this signal by 49 dB, which leads to the post-filtered signal level of (-30 dBm-49 dB= -79 dBm). Thus, no desensitization was observed in case of a Band 17 receiver.[46]

The impact of the ACI on the device performance and the impact of the intermodulation interference on the device performance are cumulative. The ACI (*e.g.*, x mW) and the intermodulation interference (*e.g.*, y mW) would add together (*i.e.*, (x+y) mW) and raise the overall noise floor above the thermal noise floor to a greater extent compared to the ACI-only case and the intermodulation-only case.[47]

Qualcomm's E block interference analysis cannot provide definitive conclusions as to (i) *precisely* where such interference will occur (due to the lack of commercial E block networks) or (ii) the specific amount of degradation Band 12 devices will incur relative to Band 17 devices in terms of throughput and other QoS metrics. However, Qualcomm's technically sound analysis provides informed estimates as to the approximate E block signal levels at which Band 12 device performance is likely to degrade relative to Band 17 devices, and the general areas around the E block transmitters where the E block interference is likely to occur.

2.3. THE IMPACT OF THE GREATER INTERFERENCE THAT CHANNEL 51 AND E BLOCK SIGNALS IMPOSE ON BAND 12 DEVICES COMPARED TO BAND 17 DEVICES

As explained in Section 1, increased interference decreases SIRs and increased desensitization of the device, resulting in reduced throughput, smaller effective cell sizes or reduced coverage, and dropped calls and access failures. It also reduces the areas where high order modulation schemes that support higher throughput levels can be used. The end result from the customer's point of view is lost coverage, dropped connections, and slower throughput, which in turn reduces the quality of service and can make certain services, such as video services and gaming, unusable.

A large number of customers are likely to experience such degraded performance if AT&T is forced to use Band 12 devices, rather than Band 17 devices. The testing and analyses conducted by Qualcomm, PCTEST, and 7Layers show Channel 51 interference will begin to adversely affect device and network performance in areas where unfiltered Channel 51 signal levels at the device antenna are above -30 dBm (or even lower when, as will typically occur, the user's device receives a partial allocation the resource blocks available in a cell), and E block interference will adversely affect device and network performance where E block signal levels are above about -49 dBm. Qualcomm has provided maps for various cities identifying the areas where these signal levels likely exist according to well-established FCC-approved propagation modeling tools (for Channel 51) and its own drive tests (for E block).

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[46] Qualcomm, at 23-24.

[47] *See also* Qualcomm, at 24 ("It is important to recognize that the blocking and intermodulation interference . . . are cumulative").

AT&T has used these maps to determine the portion of its "average busy hour"[48] traffic for the cellular market areas ("CMAs") covering the cities examined by Qualcomm that occurs in the areas where Channel 51 and E block signals are at or above the levels that the testing by Qualcomm, PCTEST and 7Layers show result in degraded service for Band 12 devices, but for Band 17 devices. This analysis (attached to this paper as Exhibit C) show that for Kansas City, MO, Providence, RI, and Chicago, IL, about 70 percent or more of AT&T's average busy hour traffic is located in areas where Channel 51 signal levels are at or above -30 dBm.[49] Similarly, this analysis shows that for Dallas/Fort Worth 28% of AT&T's average busy hour traffic is in areas E Block signal levels would likely exceed -49 dBm.

3. THE WIRELESS STRATEGIES TESTS AND MITIGATION PROPOSALS

Two day before we submitted our initial paper, Wireless Strategies submitted a 76 page report purporting to show that Band 12 devices would not experience degradation in performance caused by Channel 51 and E block signals. In our initial paper, we explained that Wireless Strategies analyses were fundamentally flawed in multiple respects. Qualcomm identified many of the same flaws (and others). We have confirmed that our prior criticisms were correct and identified additional problems with Wireless Strategies' analyses.

3.1 The Field Tests Conducted By Wireless Strategies.

Wireless Strategies purports to have conducted extensive field testing in Atlanta to measure Channel 51 and E Block signals at ground level. In addition to the various problems with Wireless Strategies' field testing identified in our initial report and in Qualcomm's comments, it is clear from Wireless Strategies' more detailed report that these field measurements are flawed.

Channel 51 Field Measurements. As Qualcomm correctly points out, "when conducting interference analysis, engineers examine worst-case scenarios, such as where user equipment is located immediately adjacent to the interfering transmitter, or other geographical areas where consumers devices are vulnerable."[50] In addition to testing near the interfering transmitter, field tests must also measure signal levels inside buildings, particularly on higher floors, where Channel 51 signal levels may be greater and cell signals may be lower. Moreover, tests should be conducted where Channel 51 transmitters are located within highly populated metropolitan areas, where signal levels may vary greatly as they are affected by buildings and other structures.

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[48] The average busy hour was calculated by determining for each cell site the 10 busiest hours and taking an average of the traffic for those 10 hours.

[49] Qualcomm also provides data showing that Channel 51 signals exceed -30 dBm along busy commuter corridors, such as Montclair, NJ.

[50] Qualcomm, at 55-56.

The field tests in the Wireless Strategies Report, however, appear to have tested Channel 51 signal levels in the *best case* scenario – that is, where Channel 51 signals are likely lowest and where cellular signals are likely greatest. Wireless Strategies measured signal levels from a Channel 51 transmitter located far outside the Atlanta metropolitan area, and then measured signal levels only in locations that were at least 2 kilometers away from the interfering transmitter,[51] and only at ground level[52] where Channel 51 signals are likely to be lowest and cellular signals are likely to be highest. Nor does Wireless Strategies report any indoor test results where Channel 51 signals are likely to be much higher relative to cellular signals, especially on higher floors.

The results of Wireless Strategies' field tests illustrate these flaws. As Wireless Strategies admits, the maximum Channel 51 signal it measured was "on a hilltop near the tower."[53] This fact strongly indicates that if Wireless Strategies had measured Channel 51 signal levels closer than 2 kilometers from the Channel 51 transmitter, or at higher levels, such as in higher floors of office buildings, it would have obtained much higher signal level readings.

Wireless Strategies points to a test conducted by Nokia in Finland that it says supports its findings. It does not. The Nokia test measured signal levels for analog and digital television stations operating at about half the power of Channel 51 broadcasts. Yet, even at these lower power levels, Nokia measured signal levels that were *much higher* than those found by Wireless Strategies for Channel 51. For example, Nokia's measurement of the Channel 52 signal strength (which is an analog TV signal operating in Finland around 722 MHz at 600 kW effective radiated power ("ERP")), was -21 dBm within about 1 kilometer of the transmitter. Similarly, Nokia's measurement of the Channel 46 signal strength (which is a digital TV signal operating at around 674 MHz at only 50 kW ERP), was about -23 dBm within about 1.5 kilometers of the transmitter. Thus, Nokia found that even a digital television station broadcasting at only 50 kW produced ground level signal levels of -23 dBm within 1.5 kilometers of the transmitter. This strongly indicates that a 1000 kW digital television station – like Channel 51 – will produce much higher signal levels that far exceed -23 dBm within 1.5 kilometers of the station. As PCTEST's analysis shows, at about -24 dBm Channel 51 interference levels, a Band 12 device will be unable to connect to the LTE network, whereas Band 17 devices will operate within 3GPP specifications.

Wireless Strategies also states that it tested ground level signal levels from a 12.5 kW low power television station (Channel 47 in Norcross Georgia) and found those signals to be as high as -21 dBm immediately adjacent to the transmitter. This finding further highlights the fact that signal levels from a 1 MW television stations such as Channel 51 in areas close to the transmitter will be much, much higher than the -21 dBm for a mere 12.5 kW signal.

[51] Wireless Strategies Report, at 52.

[52] Wireless Strategies Report, at 52.

[53] Wireless Strategies Report, at 52.

In addition, we note that the Channel 51 transmitter for Atlanta relied on by Wireless Strategies appears to be a very poor choice for assessing the likely worst case scenario for interference from Channel 51 transmissions. The transmitter is located in Rome, Georgia, far outside downtown areas. A more appropriate example would be downtown Kansas City where the transmitter is located in the city. In this area there are myriad office buildings and residences located within a kilometer or two of the transmitter, and many of the office buildings are skyscrapers where people and their mobile devices will be located far above ground level and close to the Channel 51 transmitter. As explained above, FCC-approved modeling tools and data confirms that in the areas covering downtown Kansas City, Channel 51 signal levels can be expected to be above -30 dBm, which are power levels shown by PCTEST and 7Layers to result in strong reverse intermodulation that significantly degrades the performance of Band 12 devices, but not Band 17 devices.

E block Field Measurements. The Wireless Strategies Report confirms that its field tests purporting to measure E block signal levels in Atlanta are also fundamentally flawed. There are currently no deployed E block networks. However, Dish Network has conducted tests of an E block network in Atlanta. The Wireless Strategies Report relies on E block signal levels created by these tests. As we have explained, signal levels produced by the mini-E block network used in these tests provide little indication of what signal levels would be in a commercially deployed E block network. In this respect, we agree with Qualcomm that "[t]he layout of the mini-E block test system tested in Atlanta does not represent either a worst-case scenario (which should be tested when analyzing interference) or a real-world scenario."[54]

The only entity that has deployed a commercial mobile video service in Atlanta is Qualcomm. Qualcomm's network used D block spectrum operating at 50 kW. Accordingly, a mobile video service using E block operating at 50 kW, as Dish Network is proposing to do, would likely require a similar architecture to cover Atlanta. According to Qualcomm, it required 13 transmitters to adequately serve the Atlanta market.[55]

Dish Network conducted several different E block tests in Atlanta. These tests included a 3 phase test to assess "the feasibility of a single frequency network ("SFN")."[56] In Phase I of the test, Dish Network tested its system using three towers, only one of which was operating at the maximum permissible 50 kW ERP; in Phase II, Dish Network tested its system using three towers operating at the maximum permissible 50 kW ERP; and in Phase III, Dish Network

[54] Qualcomm, at 32.

[55] *See* Letter from Jim Bugel (AT&T) to Marlene H. Dortch (FCC), WT Docket No 11-18, RM-11592 (December 7, 2011).

[56] 700 MHz Interim Performance Status Report of Manifest Wireless L.L.C., at 4 *available at* https://wireless2.fcc.gov/UlsEntry/attachments/attachmentViewRD.jsp?applType=search&fileKey=1238997006&attachmentKey=18840808&attachmentInd=licAttach.

"added three additional tower sites [for a total of 6 sites] each transmitting at 50 kW ERP *to finalize the network*."[57]

Wireless Strategies appears to have conducted its field tests of E block signal when Dish Network was operating only three sites at the maximum permissible 50 kW ERP.[58] But as Dish Network has explained, it required a total of 6 sites each operating at 50 kW ERP to "finalize" its test network, and Qualcomm has explained that it required 13 sites for the commercial version of its network in Atlanta. Thus, the environment in which Wireless Strategies tested E block signal levels – with only 3 transmitters operating at 50 kWs – was one with far fewer E block transmitters than would likely exist in any E block commercial network. As such, the E block signal levels they measured Atlanta likely greatly understate actual E block signal levels that would exist in any real world network.[59]

Nonetheless, Wireless Strategies flawed field tests still measured E block signal level that it concedes would cause Band 12 devices to operate below 3GPP specifications. Wireless Strategies admits that, according to 3GPP specifications, E block signals exceeding -56 dBm "may degrade . . . performance, causing bit errors or interrupting communications."[60] Wireless Strategies further admits that even with only three E block transmitters operating at 50 kW in Atlanta, it observed large areas with E block signal levels above -56 dBm, and, indeed, many areas where signal levels exceed -16 dBm.[61] In these areas, therefore, devices would be operating in an environment where 3GPP standards indicate service would be degraded, potentially significantly.

Wireless Strategies recognizes that even its own field testing confirms that E block transmissions will exceed 3GPP thresholds. Wireless Strategies, therefore, tries to make the

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57 700 MHz Interim Performance Status Report of Manifest Wireless L.L.C., at 4 *available at* https://wireless2.fcc.gov/UlsEntry/attachments/attachmentViewRD.jsp?applType=search&fileKey=1238997006&attachmentKey=18840808&attachmentInd=licAttach (emphasis added).

58 *See* Wireless Strategies Report, at 13. It appears from the Wireless Strategies report that a fourth tower was operating at 20 kW.

59 Wireless Strategies asserts that the number of sites is "immaterial" to the analysis. But Wireless Strategies' argument is based on a false premise. It assumes that adding more cell sites is relevant only if it results in a higher maximum signal level. Even if it were true that adding more E block sites would not increase the maximum E block signal level in Atlanta, it is indisputable that adding additional E block sites would increase the number of areas with high E block signals. For example, adding an E block transmitter in an area that previously had a very weak E block signal level, would significantly increase the signal level in that area.

60 Wireless Strategies Report, at 20.

61 Wireless Strategies Report, at 28, Figure 4.5.

case that commercial devices can exceed 3GPP minimum specifications, and can thus sometimes accommodate interference that exceeds the permissible levels under 3GPP specifications. In this regard, Wireless Strategies argues that AT&T's and Verizon's LTE transmissions can exceed -56 dBm and that AT&T's and Verizon's devices are capable of operating in that environment.

There are multiple problems with this argument. First, it requires the FCC to assume that all devices will be capable of operating in environments with interference exceeding 3GPP specifications, and that the Commission should thus ignore the 3GPP interference specifications in this proceeding. As explained below, that is not a safe assumption.

More importantly, Wireless Strategies' argument that AT&T must already contend with interference from Verizon's LTE transmissions is another reason why the *addition* of E block interference would be especially harmful. Interference at the device is *cumulative*. If it is true, as Wireless Strategies suggests, that AT&T must already contend with significant interference from adjacent LTE transmissions by Verizon, forcing AT&T to also contend with additional interference from E block transmissions could result in significant performance degradation even if the device was operating above minimum 3GPP specifications in order to contend with the interference from Verizon.

3.2 The Interference Analysis Conducted By Wireless Strategy

As we explained in our initial paper, the central scientific hypothesis here is that Band 12 devices will experience greater interference than Band 17 devices when subject to Channel 51 and E Block transmissions. Hence, a mandate requiring AT&T to use Band 12 rather than Band 17 would result in degraded service for AT&T customers, and potentially even lost service in some areas, and would force AT&T to incur costs associated with partially mitigating such interference.

The Wireless Strategies Report does not even address this central hypothesis. Instead, its analyses and testing focus on whether a Band 12 device would still operate in the presence of additional interference from Channel 51 and E block transmissions. But whether a Band 12 handset will continue to operate provides no indication of the harm that a Band 12 mandate would cause, because it ignores the fact that such a mandate would result in lower throughput, smaller effective cell areas, lost connections, and other harms.

In any event, even Wireless Strategies' attempt to analyze whether a Band 12 device will work normally in the presence of Channel 51 and E block transmissions is fundamentally flawed.

Channel 51. We identified multiple problems with Wireless Strategies' analysis of Channel 51 interference in our initial paper. Further examination of the Wireless Strategies' paper confirms our prior findings, as well as additional problems. For example, the Wireless Strategies analysis incorrectly assumes that harmful Channel 51 reverse intermodulation interference can occur only when the device "transmit[s] at maximum power" and that devices operate at maximum power only at the cell edge[62] As an initial matter, it is not true that intermodulation interference occurs only when the device is operating at or near maximum power. The only pre-requisite is that the power amplifier is transmitting in a non-linear region, which it may do at a lower than the maximum power level. As shown by Qualcomm, reverse intermodulation products occur at various power levels. Qualcomm carried out the reverse intermodulation testing in three different states: high gain state (where the transmit power is close to the maximum transmit power), medium gain state, and low gain state. Qualcomm's testing shows that non-linearity in the power amplifier is often higher in lower gain states than in higher gain states.[63] Qualcomm's testing finds that the Channel 51 signal level is much more critical in deciding the existence and severity of reverse intermodulation, and that the absolute power level of the device's transmit power is much less important. In short, significant reverse intermodulation interference can exist even when the device's transmit power is substantially below the maximum transmit power.

It is also not true that devices operate at maximum power only at the cell edge. As we demonstrated in our initial paper, devices can operate at maximum power anywhere in a cell, because the power used by a device depends not only on the distance to the cell but on other factors as well. For example, a device may operate at high power (even maximum power) when services that require high bandwidth are used, even if the device is located near the middle of the cell.

In any event, Wireless Strategies never actually tests the extent to which a Band 12 device will be subject to interference compared to a Band 17 device. Wireless Strategies only tested a Band 17 device, and learned what was already known: Band 17 devices are not subject to significant interference from Channel 51 interference.

To guess how intermodulation interference would impact a Band 12 device, Wireless Strategies used transmissions in different frequencies, with different transmit/receive spacing and purports to have applied "[t]he IM product amplitude . . . to third order response formulas to derive the device power amplifier third order output intercept point (OIP3)" to represent what would occur when an actual Channel 51 transmission occurred in the presence of an actual Band 12 device.[64] Wireless Strategies provides no technical or other justification for using such a formula. As Qualcomm correctly points out, "there is not a recognized formula of estimating this type of interference,"[65] as shown in a recent academic paper on this issue.[66] Furthermore,

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[62] Wireless Strategies Report, at 47.

[63] Qualcomm, at 58.

[64] Wireless Strategies Report, at 54-61.

[65] Qualcomm, at 56.

the Wireless Strategies report states that "[w]ith the power amplifier's intermodulation response determined, the impact of a Band 12 versus Band 17 filter is readily quantified." However, this method is unreliable in quantifying the relative impact of the intermodulation product of a given amplitude on Band 12 and Band 17 devices, because the intermodulation product *amplitude itself* is affected by the transmit filter of the duplexer through which the Channel 51 signal enters the device. Larger separation between a Band 17 transmit RF filter and Channel 51 would reduce the effective amplitude of the interfering Channel 51 signal that mixes with the transmit power of the mobile device to create the intermodulation distortion. In contrast, narrower separation between a Band 12 transmit RF filter and Channel 51 would lead to larger amplitude of the interfering Channel 51 signal and hence larger amplitude of the intermodulation product.

E Block Analysis. Wireless Strategies' E block analysis is likewise fundamentally flawed. Wireless Strategies does not dispute that according to 3GPP specifications, Band 12 devices are not designed to operate properly in the presence of signals above -56 dBm. As discussed above, the filters used in Band 12 devices provide only about 7 dB attenuation of E block transmissions. Thus, according to 3GPP standards, Band 12 devices are likely to experience significant performance degradation in the presence of E block signals above -49 dBm. And, Wireless Strategies admits that even in Atlanta where there were only three E block transmitters operating at full power, signal levels exceeded -49 dBm.[67]

In response, Wireless Strategies hypothesizes that Band 12 devices will all be designed to operate well above 3GPP standards and will thus be able to withstand interference levels above -49 dBm. At this point, we note that even if it is true that *some* devices may be able to withstand interference beyond the maximums specified in the 3GPP standards, there is no basis to assume that *all* such devices will exceed those 3GPP specifications. Devices come in all different shapes and sizes, with different features. The characteristics of a device reflect trade-offs. As a result, the form factor and features of some devices may allow them to operate in the presence of greater E block interference, whereas others would not.

In any case, Wireless Strategies has not shown that any Band 12 device can withstand E block interference. As noted, Wireless Strategies did not test any Band 12 devices. Rather, Wireless Strategies first asserts that AT&T's Band 17 devices already handle substantial interference from Verizon's Band 13 transmissions. But, as noted, that only further undermines Wireless Strategies argument: interference is *cumulative*. Thus, the fact that AT&T is already subject to significant interference from Verizon militates against subjecting AT&T to additional significant interference from Channel 51. Moreover, unlike a high-power broadcast interfering source,

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[66] *See, e.g.,* Allen Katz *et al.*, *Sensitivity and Mitigation of Reverse IMD in Power Amplifiers,* at 53 (2011 IEEE Topical Conference on Power Amplifiers for Wireless & Radio Applications (PAWR), No. 10.1109/PAWR.2011.5725374 (2011)).

[67] Wireless Strategies Report, at 28.

potential interference from another low-power mobile broadband network can typically be resolved through base station collocation or other network design measures.

Wireless Strategies' other basis for its contention that Band 12 devices can withstand high levels of interference is that it could effectively test how a Band 12 device would perform by testing a Band 17 device and "remov[ing] the [device's] filter from the equation."[68] In particular, Wireless Strategies subjected a Band 17 device to a 50 kW transmission generated from within the upper A and B blocks (within the passband of Band 17 devices' RF filters), and examined the signal levels at which a Band 17 device receiving in the adjacent upper C block would cease to work.[69] Wireless Strategies states that its testing found that the Band 17 device continued to work even at high virtually unfiltered E block signal levels generated from the A and B block blocks. Wireless Strategies thus concludes by analogy that a Band 12 device will work in the presence of high signal levels from the E block.

But actual testing of Band 12 devices confirms that Wireless Strategies analysis is flawed. As discussed above, analyses based on filter characteristics of actual commercially available Band 12 and Band 17 devices confirms that Band 12 devices will experience significant degradation in performance at E block signal levels of about -49 dBm, which even Wireless Strategies admits will frequently occur in a future E block deployment.

Moreover, even if Wireless Strategies were correct that all Band 12 devices would be able to withstand higher E block interference levels than specified in the 3GPP standards, the interference levels at which Wireless Strategies found E block interference to cause significant blocking will clearly exist in many areas when E block networks are deployed. According to Wireless Strategies, a hypothetical Band 12 device could withstand E block transmissions of about -30 dBm. But, as Wireless Strategies admits, it measured E block signal levels in Atlanta (where only three transmitters were operating at full power) that exceed those levels. Likewise, as discussed above, Qualcomm likewise demonstrated that E Block signal levels are often likely to exceed -30 dBm in downtown areas.[70]

In any case, Wireless Strategies' approach is conceptually flawed. Wireless Strategies appears to have examined only whether a Band 12 device might work in the presence of E block interference. But the relevant issue here is the extent to which the *performance* of the Band 12 device will degrade relative to a Band 17 device. As discussed above, Band 12 filters provide far less attenuation of E block transmissions than Band 17 filters. As a result, as shown above, Band 12 devices will experience significant performance degradation at E block signal levels where Band 17 devices will not. Wireless Strategies, by taking the filters out of the equation, thus fails to account for the significant difference in the relative performance of Band 12 and

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[68] Wireless Strategies Report, at 23.

[69] Wireless Strategies Report, at 23.

[70] Qualcomm, at 25-28.

Band 17 devices in the presence of E block signals, and instead incorrectly examines only whether such devices are likely to work at all.

3.3 Wireless Strategies Proposed Mitigation Techniques.

Wireless Strategies admits that in some areas, interference from Channel 51 and E block transmissions may cause harmful interference to Band 12 devices. However, Wireless Strategies argues that such harmful interference can be adequately mitigated by the addition of base stations, network optimization, restrictions on channel bandwidths, and base station scheduler modifications. We demonstrated in our initial paper that these approaches cannot fully mitigate E block and Channel 51 interference, and that there are significant cost and practical impediments to implementing the mitigation strategies proposed by Wireless Strategies.

With respect to E Block interference, Wireless Strategies states that "a Band 12 Lower B and C Block operator may plan their system design to prevent interference to the hypothetical 3GPP reference receivers. Such planning would not incur added cost, but would simply add one further consideration in the site selection process. No additional sites or other equipment would be needed to ensure adequate reception for Lower B and C devices."[71] But AT&T has already deployed its network. It clearly would incur significant costs to implement interference mitigation of E block transmissions, and as we explained in our previous paper, E block interference cannot be fully mitigated.

Qualcomm also explains that E block interference cannot be fully addressed by collocating LTE base stations (eNodeBs) at E block sites, for multiple reasons. First, E block networks are not yet deployed. Consequently, mobile providers would be forced to continually redesign their networks if they seek to collocate an eNodeB on every new E block site that is built. Moreover, this may amount to thousands of sites throughout the country, and collocation may not even be feasible at many sites. In any event, as Qualcomm correctly points out, an E block site will have different propagation characteristics than an LTE site (*e.g.,* different distances between cells and antenna down-tilts). Consequently, collocating an eNodeB at an E block transmitter can, at best, only partially mitigate E block interference.[72]

Wireless Strategies' assertion that carriers typically address interference between their networks through collocation is irrelevant here. It is much easier to manage interference between homogenous cellular networks than between heterogeneous cellular and broadcast networks. Cellular operators have the ability to collocate with each other to insure consistency in coverage and propagation. By contrast, cellular operators have not had to face the issue of one operator operating at 50 kilowatts of power.

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[71] Wireless Strategies Report, at 41.

[72] *See also* Qualcomm, at 30-31.

Wireless Strategies also suggests that providers could avoid Channel 51 intermodulation interference by reducing instances in which mobile device amplifiers produce non-linear output by adding cell towers or by altering the software algorithms. But, as Qualcomm's analyses show, nonlinearity of the device's power amplifier exists at different (and not just at maximum) power levels. In any case, because a device may utilize any gain level at any given moment, adding cell towers would not alleviate the reverse intermodulation problem.[73]

Lastly, Wireless Strategies suggests that to avoid interference, carriers could configure the one or two sites closest to the DTV 51 tower as 5 MHz LTE sites, rather than 10 MHz LTE sites. But this extreme measure would literally cut sector or cell capacity in half. Furthermore, as the Qualcomm, PCTEST and 7Layers analyses show, many more eNodeBs than just those located near the Channel 51 transmitter would be affected. In any event, even if a service provider were to accept a 50 percent reduction in capacity and throughput at many eNodeBs, non-trivial RF re-planning and re-design would be needed to identify all the cells that would be affected and reconfiguration of these cells would be needed. Potential design changes in the scheduling algorithm (which is proprietary to equipment manufacturers) might be needed, requiring testing of different scenarios. All of these changes affect the activities carried out by RF engineers to optimize network performance to ensure an optimal subscriber experience. Furthermore, while user traffic can be allocated a desired portion of the spectrum, some control channels (e.g., Physical Uplink Control Channels) typically reside on the left and right edges of the channel, and it would be impractical to simply use one side of the spectrum bandwidth (*i.e.*, use of only 5 MHz spectrum bandwidth instead of the available 10 MHz spectrum bandwidth).

3.4 The V-COMM Report.

We note that V-COMM, L.L.C. ("V-COMM") has now submitted a report purporting to analyze the relative impact of Channel 51 and E block signals on Band 12 and Band 17 devices.[74] This report was submitted one business day before the due date for filing reply comments in this proceeding. Consequently, we have not had sufficient time fully to evaluate the study. However, certain aspects of this paper stand out, and merit brief discussion here.

Most fundamentally, the V-COMM Report confirms that there are large areas where Channel 51 signals exceed -30 dBm and E block signals exceed -49 dBm, which, as shown above, are the signal levels PCTEST, 7LAYERS and Qualcomm all found would cause degradation in performance for Band 12 devices, but not for Band 17 devices.

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[73] Qualcomm, at 54.

[74] *See* Reply Comments of V-COMM, L.L.C. Prepared on Behalf of Cavalier Wireless, Continuum 700, King Street Wireless, MetroPCS Communications, Inc., and Vulcan Wireless, WT Docket No. 12-69 (July 13, 2012) ("V-COMM Report").

The main focus of the V-COMM Report is on trying to show that Band 12 LTE devices will not experience significant interference at these signal levels. Our initial review of the V-COMM Report, however, raises significant questions about these analyses.

Most notably, V-COMM purports to have conducted field tests to measure the impact of Channel 51 reverse intermodulation interference using Band 12 devices. According to the V-COMM report, there is no dispute that a Band 12 device will not experience degraded performance from Channel 51 interference if the LTE network is operating only in the B Block. V-COMM contends that it tested the impact of Channel 51 interference on Band 12 devices on U.S. Cellular's network in Waterloo, IA, first operating using only B block spectrum (where Channel 51 reverse intermodulation interference would not occur), then using B and C block spectrum (where channel 51 reverse intermodulation products would be produced). V-COMM asserts that it found no difference in performance, and it thus concludes that Band 12 devices operating on networks using the B and C blocks do not experience significant performance degradation in the presence of Channel 51 signals. These, however, tests are fundamentally flawed in multiple respects.

First, as noted, these field tests were conducted in and around Waterloo, Iowa, which is located nearly 60 miles away from the nearest Channel 51 transmitter, which is in Cedar Rapids, Iowa. It is therefore unlikely that Channel 51 signal levels in Waterloo were at the levels that have been shown to cause degradation in performance for Band 12 devices, *i.e.,* above about -30 dBm. Indeed, the propagation modeling reported by V-COMM shows that Channel 51 signal levels in Waterloo are generally in the sub-70 dBm to -40 dBm range, and that almost all of V-COMM's drive testing device performance measurements occurred in these areas where Channel 51 signal levels are predicted to be below -30 dBm.[75]

The depiction of the drive-test route in the V-COMM report appears to include a small portion of their field measurements in areas where Longley-Rice propagation modeling predicts Channel 51 signal levels above -30 dBm. There appears to have been only a small number of measurements in these areas, and because V-COMM reports only the overall average of the field test readings, any poor performance measured in these areas would certainly be masked by the large number of test points in areas where Channel 51 signal levels were well below -30 dBm.

We also find it curious that V-COMM chose to rely on propagation modeling, rather than actual field test measurements of Channel 51 signal levels in these areas, especially given that elsewhere in V-COMM's report it reports the results of drive tests in Cedar Rapids proper near the Channel 51 tower. If V-COMM conducted field test measurements of Channel 51 signal levels in Cedar Rapids, it presumably did (or at least could) conduct similar measurements for Waterloo at the same time its was taking its device measurements.

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[75] *See* V-COMM Report, at 29.

V-COMM's analysis is also conceptually flawed. It is well established that 10 MHz LTE deployments (e.g., combined B and C blocks) are more efficient than 5 MHz deployments (e.g., B block only), and thus that throughput available in a 10 MHz deployment will be not just double the throughput of a 5 MHz deployment (because double the amount of spectrum is deployed), but *more* than double. V-COMM's rough throughput distribution comparisons are meaningless, because any difference in throughput levels reflect the *net impact* of increased throughput due to greater efficiency and degraded throughput due to interference.

We also find the other results presented in the V-COMM Report to be highly questionable. The V-COMM Report contains results that are vastly different from the multiple other independent tests and analyses that have been conducted and reported in this proceeding. For example, V-COMM concludes that Band 12 devices will be adversely affected by Channel 51 and E block signal levels that are far above the levels that independent testing by PCTEST, 7LAYERS, and Qualcomm found would cause Band 12 devices to experience severe performance degradation.

Moreover, the V-COMM Report omits critical information needed to evaluate why it reached such different results from the three other independent tests. For example, one of the most critical values when using lab tests to evaluate the impact of Channel 51 interference is the LTE signal level (from the base station to the device). It takes higher Channel 51 signal levels to cause interference where LTE signal levels are highest. While evaluating the impact of interference, LTE signal levels should be set at the level that is close to where the device is just able to detect the signal and receive packets (which corresponds to the conditions near the cell edge). PCTEST and 7Layers added 3 dB to such LTE signal level to ensure adequate signal strength. By adding 3 dB, the LTE signal levels used in the test are those that typically occur in the areas between the cell mid-point and cell edge. To the extent that V-COMM might have used higher LTE signal levels, V-COMM was effectively measuring the impact of interference much closer to the cell, which would explain why it found Band 12 devices to be able to withstand much higher Channel 51 and E block signal levels. V-COMM, however, does not identify the LTE signal levels it used in its tests.

Nor does V-COMM identify how it measured or computed the desensitization values it relies upon for its conclusion that the performance of Band 12 devices does not significantly degrade in the presence of Channel 51 signals. As discussed above, desensitization is a measure of degradation in device performance in the presence of an interfering signal. It is difficult to properly measure desensitization for a commercial device in cases such as reverse intermodulation, and V-COMM provides no explanation as to how it determined desensitization.

REFERENCES

[1] Jeffrey H. Reed & Nishith D. Tripathi, *Impact of E block Interference on Band 12 and Band 17 User Equipment Receivers,* at 5-8, *attached to* Comments of AT&T Services Inc., WT Docket No. 12-69 (June 1, 2012).

[2] Comments of Qualcomm Incorporated, In the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum and Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69 and RM-11592 (Terminated), at 37 (June 1, 2012).

[3] Allen Katz *et al.*, *Sensitivity and Mitigation of Reverse IMD in Power Amplifiers,* at 53 (2011 IEEE Topical Conference on Power Amplifiers for Wireless & Radio Applications (PAWR), No. 10.1109/PAWR.2011.5725374 (2011)).

[4] Comments of Motorola, In the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum and Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69 and RM-11592 (Terminated), at 2 (June 1, 2012).

[5] Nishith Tripathi and Jeffrey Reed, "Cellular Communications: A Comprehensive and Practical Guide," To be Published by IEEE/Wiley, 2012.

[6] Agilent, "The Use of Intermodulation Tables (IMT) for Mixer Simulation," http://cp.literature.agilent.com/litweb/pdf/5989-9470EN.pdf; Radha Setty, Daxiong Ji and Harvey Kaylie, "Figure of Merit of Mixer Intermod Performance," AN-00-001, http://www.minicircuits.com/app/AN00-001.pdf.

[7] Letter from Jim Bugel (AT&T) to Marlene H. Dortch (FCC), WT Docket No 11-18, RM-11592 (December 7, 2011).

[8] 700 MHz Interim Performance Status Report of Manifest Wireless L.L.C., at 4 *available at* https://wireless2.fcc.gov/UlsEntry/attachments/attachmentViewRD.jsp?applType=search&fileKey=1238997006&attachmentKey=18840808&attachmentInd=licAttach.

[9] Reply Comments of V-COMM, L.L.C. Prepared on Behalf of Cavalier Wireless, Continuum 700, King Street Wireless, MetroPCS Communications, Inc., and Vulcan Wireless, WT Docket No. 12-69 (July 13, 2012).

EXHIBIT A

Test Methodology to Assess Interference to Band Class 12 and 17 LTE Devices from Channel 51 Broadcasting

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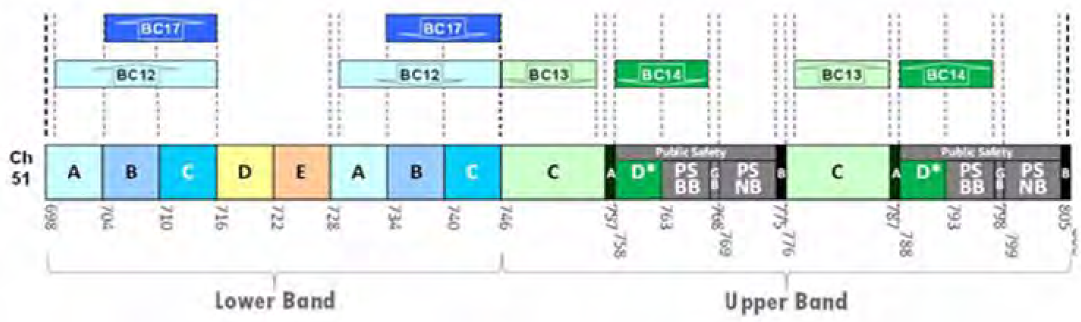
Purpose and Scope

This test plan defines the test methodology which shall be used to evaluate the effects of interference to victim 3GPP Band 12 User Equipment (UE) and Band 17 UE associated with signals from Channel 51 broadcasting.

Introduction

When the 700 MHz Commercial Mobile Radio Service (CMRS) band was proposed in 2008, the FCC allocated frequency “blocks” for auction which were based on the UHF television channels that formerly utilized this spectrum. For example, UHF channel 52 (698-704 MHz) became Block A, UHF channel 53 (704-710 MHz) became Block B, etc. A diagram which depicts the frequencies of the “blocks” in the 700 MHz band is shown in Figure 1.

Figure 1   700 MHz US Block Allocations



"BCxx" indicates Band Classes proposed as part of the international 3GPP industry LTE technical standards processes.
*The D Block will be reallocated for use by public safety entities as directed by recent Congressional mandate.

Within the three lower 700 MHz blocks allocated by the FCC, the industry, through 3GPP, established two FDD LTE radio bands: Band 12 and Band 17.

3GPP Band 12 is 17 MHz wide in each allocation, with the lower frequency allocation between 699 and 716 MHz. The Band 12 upper allocation covers 729 to 746 MHz. Block A's lower edge was offset 1 MHz from the "Block A" lower band edge in order to help mitigate the effects of out-of-band emissions from Channel 51 broadcasting in the adjacent channel. 3GPP Band 17 is 12 MHz wide, and covers 704-716 MHz in the lower allocation and 734 to 746 MHz in the upper allocation.

3GPP also determined that the lowest frequency blocks of these paired allocations would be used as the UE transmit (uplink), and the higher paired allocations would be used as the UE receive (downlink). This allocation placed the UE receiver as far away as possible from broadcasting in Channel 51.

From an UE perspective, the combination of Channel 51 broadcasting and lower-700 MHz LTE results in the potential for interference to the UE receiver from IMD generated in the UE transmitter. This IMD concern arises when: (a) the UE transmitter is active; (b) the UE is in the presence of a Channel 51 signal and (c) a non-linearity in the UE transmitter PA allows the creation of third-order intermodulation products.

These third-order IMD products are unique in that they can only be generated in the UE's transmitter, where the products will either be radiated by the UE's antenna and/or coupled into the UE's receiver through the duplexer.

Test Cases

All test cases described in this document are intended to be executed on a fully calibrated test platform capable of meeting the following criteria:

- Support of 3GPP Bands 12 and 17
- Emulation of a Channel 51 broadcast transmitter at a maximum power level of -20 dBm/6 MHz at the UE antenna port
- The Channel 51 broadcast emulator above must be capable of attenuating wideband noise in the 734-746 MHz range to a power of less than -90 dBm/10 MHz (-160 dBm/Hz) when generating a -20 dBm/6 MHz downlink signal.

1.1 Channel 51 Interference to Band 12 User Equipment Operating in 700 MHz Blocks B and C, Full Downlink Allocation

1.1.1 Test Purpose

This test is intended to determine whether the presence of a signal from Channel 51 will create a third-order intermodulation product which causes interference to a Band 12 UE receiving in the 734-746 MHz “B” and “C” Blocks and transmitting in the 710-716 MHz “C” Block.

1.1.2 Test Equipment Configuration

The Rohde & Schwarz TS8980FTANetOp conformance test platform is recommended for this test. This platform shall be configured according to the parameters listed in Table 1.1.2 below:

Table 1.1.2 Rohde & Schwarz TS8980FTANetOp Configuration Parameters for Channel 51 Interference to Band 12 Blocks B/C

Parameter	Value	Comments
Band 12 Operating Bandwidth/Mode	10 MHz/FDD	
Band 12 Downlink Resource Block Allocation Details	Channel 5130 RBstart=0 RBalloc=50	
Band 12 Uplink Resource Block Allocation Details	Channel 23130 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands (see text)
LTE Downlink Power at UE Antenna Port	Maximum of -91 dBm/10 MHz	Corresponds to REFSENS + 3dB, (see text)
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz (See text)	Power will be varied to determine impact of UE TX IMD

1.1.3 Test Methodology

1.1.3.1 The Rohde & Schwarz TS8980FTANetOp conformance test system shall be configured according to the parameter settings in Table 1.3.2 above. The DUT will be initially tested with an uplink allocation of 20 RB per 36.521-1, Table 7.3.3-2. This will allow the lab to verify that the DUT meets the reference sensitivity called for by 36.521-1, Table 7.3.3-1 without any variance from the 3GPP-specified procedure. However, the number of uplink RB allocations called for in the 3GPP Reference Sensitivity measurement exceeds 12, therefore, the UE will impose MPR. Because the UE is operating in QPSK, the MPR shall be ≤ 1 dB per 36.521-1, Table 6.2.3.3-1. The lab shall verify that the uplink integrated output power at the antenna port of the UE is within 1 dB of the Power Class 3 power level of +23 dBm. All remaining test platform parameters shall be set according to the Initial Conditions for reference sensitivity (REFSENS) measurement described in 36.531-1, Section 7.3.4.1.

1.1.3.2 Execute a REFSENS conformance measurement per the procedure described in 36.521-1, Section 7.3.4.2. During this measurement, the Channel 51 emulator shall be disabled so that the DUT's reference sensitivity can be tested for conformance exactly per the 3GPP standard. The lab shall verify that the DUT meets the minimum conformance requirements for QPSK REFSENS described in 36.521-1, Section 7.3.3 before continuing.

1.1.3.3 Once the lab has established that the DUT meets the conformance requirements described in 36.521-1, Section 7.3.3, the Band 12 Block B/C downlink signal power shall be lowered in 0.5 dB steps until the 95% throughput criteria of the REFSENS measurement test is just met. This will establish the actual reference sensitivity for the DUT. The actual REFSENS shall be documented along with the serial number of the DUT.

1.1.3.4 The lab shall increase the Band 12 Block B/C downlink power to a level which corresponds to REFSENS +3 dB. REFSENS, in this case, shall be the actual REFSENS measured in step 1.1.3.3 above and is not based on the conformance specification. In no case shall the downlink power exceed -91 dBm/10 MHz.

1.1.3.5 The lab shall enable the Channel 51 emulator while measuring throughput as though a REFSENS measurement is underway using the uplink RB allocation in Table 1.1.2. The Channel 51 signal shall begin at a level of -50 dBm/6 MHz and shall be increased in 1 dB increments until the Channel 51 power level at the UE antenna port equals -20 dBm/6 MHz or the radio link to the UE is lost, whichever occurs first. The downlink throughput percentage for each Channel 51 signal level shall be recorded.

1.1.4 Test Results

The following results shall be documented:

- Actual QPSK REFSENS in dBm/10 MHz along with the DUT serial number
- Actual Block B/C downlink REFSENS +3 dB power level utilized during execution of the tests in this section
- Actual uplink power level (in dBm) at the UE antenna port when the DUT is commanded to operate at P_{UMAX} .
- Channel 51 emulator power level at the UE antenna port (in dBm/6 MHz) required to reduce throughput below 95% of that specified for the RMC, using the 3GPP REFSENS measurement methodology. This Channel 51 emulator downlink power measurement shall be made to the nearest 1 dB, and shall correspond to the onset of throughput degradation. If no impairment was noted at a Channel 51 emulator power of -20 dBm/6 MHz, the documented result shall be “Inconclusive, > -20 dBm/6 MHz”.
- Channel 51 emulator power level at the UE antenna port (in dBm/6 MHz) required to drop the radio link (if applicable). This Channel 51 emulator power measurement shall be made to the nearest 1 dB. If the radio link remained active at a Channel 51 emulator power of -20 dBm/6 MHz, the documented result shall be “Inconclusive, > -20 dBm/6 MHz”, and the throughput percentage shall be documented.

1.2 Channel 51 Interference to Band 17 User Equipment Operating in 700 MHz Blocks B and C, Full Downlink Allocation

1.2.1 Test Purpose

This test is intended to determine whether the presence of a signal from Channel 51 will create a third-order intermodulation product which causes interference to a Band 17 UE receiving in the 734-746 MHz “B and “C” Blocks and transmitting in the 710-716 “C” Block.

1.2.2 Test Equipment Configuration

The Rohde & Schwarz TS8980FTANetOp conformance test platform is recommended for this test. This platform shall be configured according to the parameters listed in Table 1.2.2 below:

Table 1.2.2 Rohde & Schwarz TS8980FTANetOp Configuration Parameters for Channel 51 Interference to Band 17 Blocks B/C

Parameter	Value	Comments
Band 17 Operating Bandwidth/Mode	10 MHz/FDD	
Band 17 Downlink Resource Block Allocation Details	Channel 5800 RBstart=0 RBalloc=50	
Band 17 Uplink Resource Block Allocation Details	Channel 23800 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands (see text)
LTE Downlink Power at UE Antenna Port	Maximum of -91 dBm/10 MHz	Corresponds to REFSENS + 3 dB, see text.
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz (See text)	Power will be varied to determine impact of UE TX IMD

1.2.3 Test Methodology

1.2.3.1 The Rohde & Schwarz TS8980FTANetOp conformance test system shall be configured according to the parameter settings in Table 1.5.2 above. The DUT will be initially tested with an uplink allocation of 20 RB per 36.521-1, Table 7.3.3-2. This will allow the lab to verify that the DUT meets the reference sensitivity called for by 36.521-1, Table 7.3.3-1 without any variance from the 3GPP-specified procedure. However, the number of uplink RB allocations called for in the 3GPP Reference Sensitivity measurement exceeds 12, therefore, the UE will impose MPR. Because the UE is operating in QPSK, the MPR shall be ≤ 1 dB per 36.521-1, Table 6.2.3.3-1. The lab shall verify that the uplink integrated output power measured at the UE antenna port is within 1 dB of the Power Class 3 power level of +23 dBm. All remaining test platform parameters shall be set according to the Initial Conditions for reference sensitivity (REFSENS) measurement described in 36.531-1, Section 7.3.4.1.

1.2.3.2 Execute a REFSENS conformance measurement per the procedure described in 36.521-1, Section 7.3.4.2. During this measurement, the Channel 51 emulator shall be disabled so that the DUT's reference sensitivity can be tested for conformance exactly per the 3GPP standard. The lab shall verify that the DUT meets the minimum conformance requirements for QPSK REFSENS described in 36.521-1, Section 7.3.3 before continuing.

1.2.3.3 Once the lab has established that the DUT meets the conformance requirements described in 36.521-1, Section 7.3.3, the Band 17 Block B/C downlink signal power shall be lowered in 0.5 dB steps until the 95% throughput criteria of the REFSENS measurement test is just met. This will establish the actual reference sensitivity for the DUT. The actual REFSENS shall be documented along with the serial number of the DUT.

1.2.3.4 The lab shall increase the Band 17 Block B/C downlink power to a level which corresponds to REFSENS +3 dB. REFSENS, in this case, shall be the actual REFSENS measured in step 1.2.3.3 above and is not based on the conformance specification. In no case shall the downlink power exceed -91 dBm/10 MHz.

1.2.3.5 The lab shall enable the Channel 51 emulator while measuring throughput as though a REFSENS measurement is underway using the uplink RB allocation in Table 1.2.2. The Channel 51 signal shall begin at a level of -50 dBm/6 MHz and shall be increased in 1 dB increments until the Channel 51 power level at the UE antenna port equals -20 dBm/6 MHz or the radio link to the UE is lost, whichever occurs first. The downlink throughput percentage for each Channel 51 signal level shall be recorded.

1.2.4 Test Results

The following results shall be documented:

- Actual QPSK REFSENS in dBm/10 MHz along with the DUT serial number
- Band 17 Block B/C downlink REFSENS +3 dB power level utilized during execution of the tests in this section
- Actual uplink power level at the UE antenna port (in dBm) when the DUT is commanded to operate at P_{UMAX} .
- Channel 51 power level at the UE antenna port (in dBm/6 MHz) required to reduce throughput below 95% of that specified for the RMC, using the 3GPP REFSENS measurement methodology. This Channel 51 downlink power measurement shall be made to the nearest 1 dB and shall correspond to the onset of throughput degradation. If no impairment was noted at a Channel 51 power of -20 dBm/6 MHz, the documented result shall be “Inconclusive, > -20 dBm/6 MHz”.
- Channel 51 power level at the UE antenna port (in dBm/6 MHz) required to drop the radio link (if applicable). This Channel 51 downlink power measurement shall be made to the nearest 1 dB. If the radio link remained active at a Channel 51 power of -20 dBm/6 MHz, the documented result shall be “Inconclusive, > -20 dBm/6 MHz”, and the throughput percentage shall be documented.

EXHIBIT B

EVALUATION REPORT

Prepared for:

AT&T Services Inc.

(At the request of Counsel).

Assess Potential Interference to Band Class 12 and Band Class 17 LTE Devices from Channel 51 Broadcasting

Submitted by:

PCTEST Engineering Laboratory, Inc

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+1.410.290.6652 (Tel) • +1.410.290.6654 (Fax)
http://www.pctestlab.com

Report #: 6Y1207110023

PCTEST ENGINEERING LABORATORY, INC.

Test results reported herein relate only to the item(s) tested.

CLIENT NAME & ADDRESS:

AT&T Services Inc.
c/o KELLOGG, HUBER, HANSEN, TODD, EVANS & FIGEL, P.L.L.C.
SUMNER SQUARE
1615 M STREET, N.W.
WASHINGTON, D.C. 20036-3209
Attn: Mr. Aaron Panner

DATE & LOCATION OF TESTING:

Dates of Tests: 7/11-12/2012

Test Report S/N: 6Y1207110023

Test Site: PCTEST Lab, Columbia, MD U.S.A.

CLIENT NAME:	**AT&T Services Inc.,** **c/o KELLOGG, HUBER, HANSEN, TODD, EVANS & FIGEL, P.L.L.C**
TEST PLAN:	**Test Methodology to Access Interference to Band Class 12 and 17 LTE Devices from Channel 51 Broadcasting Services** **July 11, 2012**

EXECUTIVE SUMMARY:

Model Nos.:	**Device Number 1 (Tablet PC)**
IMEI:	**99000113214274**
Test Dates:	**7/11-12/2012**
Band Block Tested:	**LTE Band 12**
Test Results:	**See Section 3.0**

Model Nos.:	**Device Number 2 (Tablet PC)**
IMEI:	**358444040007120**
Test Dates:	**7/11-12/2012**
Band Block Tested:	**LTE Band 17**
Test Results:	**See Section 3.0**

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ilac-MRA ACCREDITED TESTING LABORATORY CERTIFICATE #2041.01

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Purpose and Scope

This report provides detailed hardware, software, test methodology, test procedures and test parameters used to determine if interference to Band Classes 12 and 17 LTE Devices from Channel 51 Broadcast Services will occur. Included in this Report are the diagrams of the test equipment hardware and software configurations used during the evaluation.

The test plan defines the Laboratory test equipment and methodology used to represent a real-world LTE digital telecommunications network operating in an environment which includes a broadcast television service operating on Channel 51. All tests were performed at PCTEST Engineering Laboratory, and in accordance with the prescribed test plan submitted by the Client–Test Methodology to Assess Interference to Band Class 12 and 17 LTE Devices from Channel 51 Broadcasting, July 11, 2012, hereafter referred to as the "test plan".

1.2 User Equipment (UE)

The LTE User Equipment (UE) was provided to PCTEST Engineering Laboratory for evaluation by the Client.

The LTE User Equipment (UE) is identified in Table 1.2.1 below:

Table 1.2.1 User Equipment Details

Sample	Device	Type of Device	IMEI
Device 1	Band 12	Tablet PC	99000113214274
Device 2	Band 17	Tablet PC	358444040007120

1.3 PCTEST Evaluation Equipment

The test systems used to represent the digital network and the digital interfering signal were the Rohde & Schwarz TS8980FTA NetOp (for automated tests) and the Manual Hardware System (for manual tests). The Rohde & Schwarz TS8980FTA NetOp is a fully validated conformance test platform system owned and operated by PCTEST. A list of the equipment is documented in Table 1.3.1 below.

Table 1.3.1 Test Equipment List

Manufacturer	Model	Description	Cal Due	Serial Number
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	08/25/2012	100976
Rohde & Schwarz	CMW500	Wideband Radio Communication Tester	10/07/2012	101767
Rhode & Schwarz	FSQ 26	Spectrum Analyzer	10/07/2012	200452
Rohde & Schwarz	AMU200A	Baseband Signal Generator	10/07/1012	100434
Rohde & Schwarz	NGMO2	Power Supply	10/07/2012	100443
Rohde & Schwarz	NRP-Z21	Average Power Sensor	10/07/2012	102531
Rohde & Schwarz	SFE100	Test Transmitter	10/07/2012	121068
Rohde & Schwarz	SFE100	Test Transmitter	10/07/2012	121069
Rohde & Schwarz	SMF100A	Signal Generator	10/07/2012	101590
Rohde & Schwarz	SMU200A	Vector Signal Generator	10/07/2012	104145
Rohde & Schwarz	MSCU-F127	MSCU Filter Module for Band 12 & 17	N/A	101034
Rohde & Schwarz	MSCU-F17	MSCU Filter Module for Band 17	N/A	100648
Rohde & Schwarz	OSP120	Open Switch & Control Platform	10/07/2012	101037
Rohde & Schwarz	AMU200A	Baseband Signal Generator	10/07/2012	100433
Rohde & Schwarz	TS-SVDLTE	SVLTE Switch	N/A	101444
Rohde & Schwarz	OSP130	Open Switch & Control Unit	N/A	100104
Symmetricom	8040C	Rubidium Frequency Std (10 MHz Ref)	N/A	C16591
Rohde & Schwarz	CMU-Z11	RF Shield Box	N/A	1150.1008.02
Agilent	8496A	110 dB Variable Attenuator	Calibrate during use	MY42146787
Agilent	8496A	110 dB Variable Attenuator	Calibrate during use	MY42147861
Agilent	8494B	11 dB Variable Attenuator	Calibrate during use	MY42152124
Agilent	8494B	11 dB Variable Attenuator	Calibrate during use	MY42152086
Agilent	11716A	Interconnect Kit	N/A	TE594350
Agilent	11716A	Interconnect Kit	N/A	TE601092
Mini Circuits	ZB3CS-900-6W-N	Splitter / Combiner	Calibrate during use	NF13490 140
Mini Circuits	ZAPD-30-S+	Power Splitter	Calibrate during use	SF937201045
AEI	AM625-875CIR191	Circulator	Calibrate during use	N/A
AEI	AM625-875CIR191	Circulator	Calibrate during use	N/A

1.4 R&S TS8980 Automated Software

The equipment software used was the Rohde & Schwarz TS8980FTA NetOp "CONTEST" SW Ver. 2.50.

1.5 R&S Automated System Hardware Test Configurations

The system hardware test equipment configuration used to emulate the digital network is the R&S TS8980 FTA NetOp. This System was used to measure throughput data for the Band 12 and Band 17 devices. The R&S Automated System Hardware configuration was used to generate a Channel 51 DTV transmitter signal that was input to the UE antenna port.

The block diagram noted below in Figure 1.5.1, describes the Rohde & Schwarz Automated System Hardware. The device used to emulate channel 51 was the R&S SFE 100 Test Transmitter.

The R&S system was used to determine the Reference Sensitivity (REFSENS) level for the UE's modulation type and RB allocations. The REFSENS level was measured for each test configuration.

The automated hardware configuration was used to determine the impact of varying interferer levels on the throughput of Band 12 and Band 17 LTE devices.

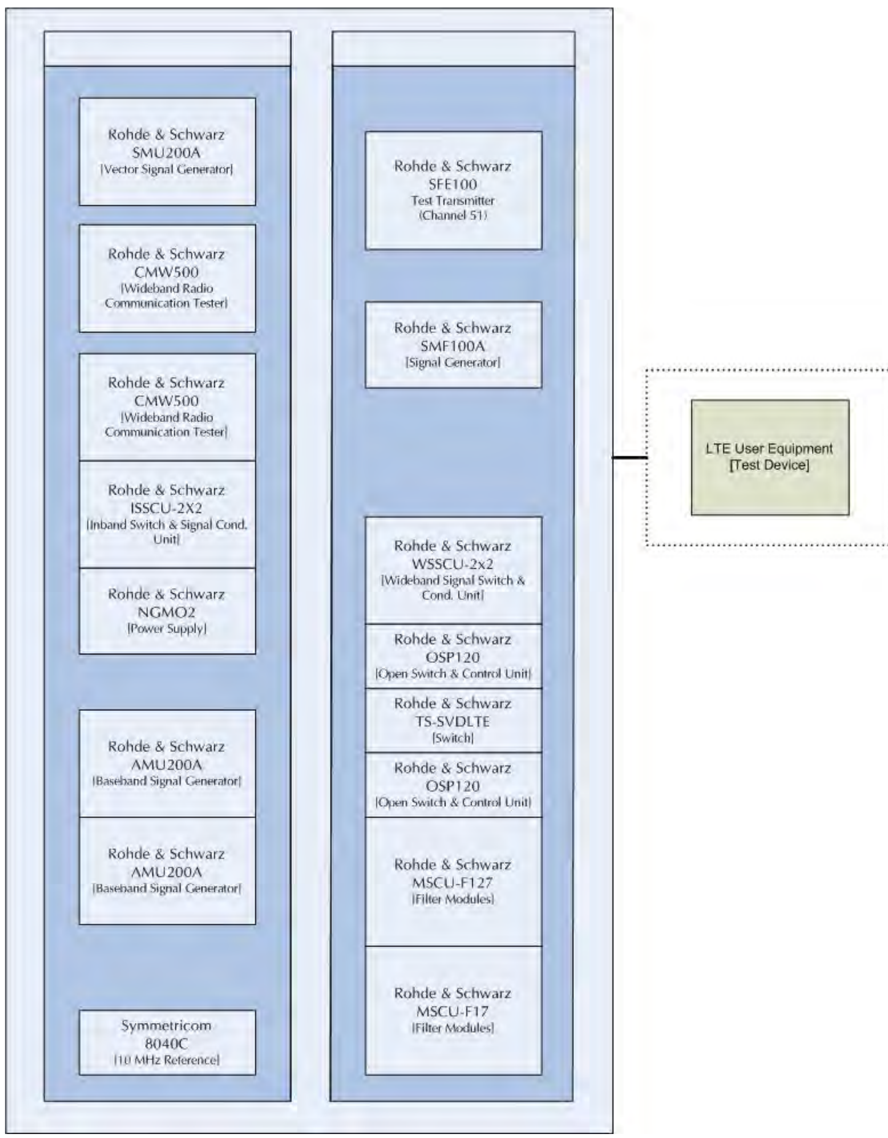

Figure 1.5.1 R&S TS8980FTA NetOp Hardware Test Equipment

1.6 Manual Hardware Test Configurations

The Manual Hardware System is used to validate the Automated System Configuration data. The Automated System software for the Rohde & Schwarz TS8980FTA NetOp is configured in the PCTEST Lab for 3GPP conformance testing, and as such maintains a connection and therefore will not determine the point at which a re-connection cannot be established.

Due to this automated software configuration, a manual hardware system was developed to evaluate the UE and determine the onset of the drop call and the level at which origination calls cannot be established or initiated due to the presence of high ChTV51 signal. The Manual Hardware Test Configuration was to facilitate determining the level where Radio Link failures (throughput degradation below 95%) coincided with LTE network inaccessibility to the user.

Figure 1.6.1 is a block diagram showing the Manual System equipment setup.

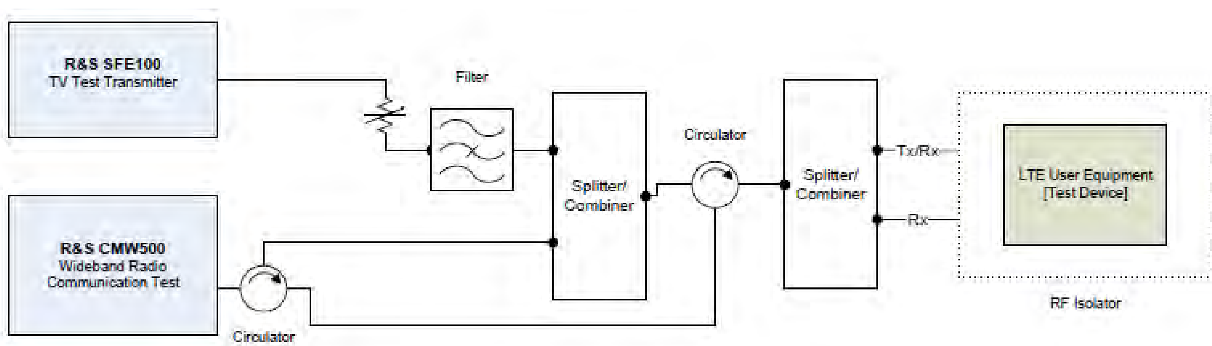

Figure 1.6.1 Manual Hardware Test Configuration

1.7 Test Conditions

The UE LTE Devices were configured with fully charged batteries and setup in a shielded chamber with a controlled environment at 25°C (+/- 2°C). The UE antenna ports were connected directly to the test equipment. The test system wideband noise floor, in the range of 734-746 MHz, was measured and confirmed to be at or below -160 dBm/Hz at the UE antenna port when the Channel 51 signal measured -20 dBm/6 MHz at the UE antenna port.

1.8 Laboratory Contact Information

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2.0 TEST PROCEDURES, PARAMETERS, AND CONFIGURATIONS

2.1 – Channel 51 Interference to Band 12 User Equipment Operating in the 700 MHz Blocks B and C, Automated Test

2.1.1 Test Purpose

This test evaluated potential interference due to the presence of a signal from DTV Channel 51 creating a third-order Intermodulation product that could cause interference to a Band 12 UE receiving in the 734-746 MHz "B" and "C" Blocks and transmitting in the 710-716 MHz "C" Block.

2.1.2 Test Procedure Variables

The Rohde & Schwarz TS8980FTANetOp conformance test platform was used for this test and was configured according to the parameters listed in Table 2.1.2 below:

Table 2.1.2 Rohde & Schwarz TS8980FTANetOp Configuration Parameters for Channel 51 Interference to Band 12 Blocks B/C

Parameter	Value	Comments
Band 12 Operating Bandwidth/Mode	10 MHz/FDD	
Band 12 Downlink Resource Block Allocation Details	Channel 5130 RBstart=0 RBalloc=50	
Band 12 Uplink Resource Block Allocation Details	Channel 23130 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands
LTE Downlink Power at UE Antenna Port	REFSENS + 3dB	
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz	Power will be varied to determine the impact of UE TX IMD.

2.2 – Channel 51 Interference to Band 17 User Equipment Operating in the 700 MHz Blocks B and C, Automated Test

2.2.1 Test Purpose

This test evaluated potential interference due to the presence of a signal from DTV Channel 51 creating a third-order Intermodulation product that could cause interference to a Band 17 UE receiving in the 734-746 MHz "B" and "C" Blocks and transmitting in the 710-716 MHz "C" Block.

2.2.2 Test Procedure Variables

The Rohde & Schwarz TS8980FTANetOp conformance test platform was used for this test and was configured according to the parameters listed in Table 2.2.2 below:

Table 2.2.2 Rohde & Schwarz TS8980FTANetOp Configuration Parameters for Channel 51 Interference to Band 17 Blocks B/C

Parameter	Value	Comments
Band 17 Operating Bandwidth/Mode	10 MHz/FDD	
Band 17 Downlink Resource Block Allocation Details	Channel 5800 RBstart=0 RBalloc=50	
Band 17 Uplink Resource Block Allocation Details	Channel 23800 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands
LTE Downlink Power at UE Antenna Port	REFSENS + 3dB	
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz	Power will be varied to determine the impact of UE TX IMD.

2.3 – Channel 51 Interference to Band 12 User Equipment Operating in the 700 MHz Blocks B and C, Manual Test

2.3.1 Test Purpose

This test evaluated potential interference due to the presence of a signal from DTV Channel 51 creating a third-order Intermodulation product that could cause interference to a Band 12 UE receiving in the 734-746 MHz "B" and "C" Blocks and transmitting in the 710-716 MHz "C" Block.

2.3.2 Test Procedure Variables

The Manual System Hardware Configuration was used for this test and was configured according to the parameters listed in Table 2.3.2 below:

Table 2.3.2 Manual System Hardware Configuration Parameters for Channel 51 Interference to Band 12 Blocks B/C

Parameter	Value	Comments
Band 12 Operating Bandwidth/Mode	10 MHz/FDD	
Band 12 Downlink Resource Block Allocation Details	Channel 5130 RBstart=0 RBalloc=50	
Band 12 Uplink Resource Block Allocation Details	Channel 23130 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands
LTE Downlink Power at UE Antenna Port	REFSENS + 3dB	
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz	Power will be varied to determine the impact of UE TX IMD.

2.4 – Channel 51 Interference to Band 17 User Equipment Operating in the 700 MHz Blocks B and C, Manual Test

2.4.1 Test Purpose

This test evaluated potential interference due to the presence of a signal from DTV Channel 51 creating a third-order Intermodulation product that could cause interference to a Band 17 UE receiving in the 734-746 MHz "B" and "C" Blocks and transmitting in the 710-716 "C" Block.

2.4.2 Test Procedure Variables

The Manual System Hardware Configuration was used for this test and was configured according to the parameters listed in Table 2.4.2 below:

Table 2.4.2 Manual System Hardware Configuration Parameters for Channel 51 Interference to Band 17 Blocks B/C

Parameter	Value	Comments
Band 17 Operating Bandwidth/Mode	10 MHz/FDD	
Band 17 Downlink Resource Block Allocation Details	Channel 5800 RBstart=0 RBalloc=50	
Band 17 Uplink Resource Block Allocation Details	Channel 23800 RBstart=45 RBalloc=5	
Output Power at UE Antenna Port	+23 dBm	System to send P_{UMAX} commands
LTE Downlink Power at UE Antenna Port	REFSENS + 3dB	
Channel 51 Emulator Power at UE Antenna Port	Between -50 dBm/6 MHz and -20 dBm/6 MHz	Power will be varied to determine the impact of UE TX IMD.

3.0 MEASUREMENT TEST RESULTS

Summary Test Data

Test Date: 7/12/2012

		% Relative Throughput based on +3 dB from the REFSENS			
		Automated Test Data using R&S TS8980 FTA NetOp		Manual Hardware Test Configuration	
		Band: 12 **INF: Channel 51** **UL: Block C** **DL: Block B & C** **RB: 50** **Mod: QPSK**	**Band: 17** **INF: Channel 51** **UL: Block C** **DL: Block B & C** **RB: 50** **Mod: QPSK**	**Band: 12** **INF: Channel 51** **UL: Block C** **DL: Block B & C** **RB: 50** **Mod: QPSK**	**Band: 17** **INF: Channel 51** **UL: Block C** **DL: Block B & C** **RB: 50** **Mod: QPSK**
		Test case 2.1	Test case 2.2	Test case 2.3	Test case 2.4
Interferer OFF	REFSENS dBm/10MHz	-100.8	-100.8	-100.7	-101.1
Interferer OFF	REFSENS +3dB	-97.8	-97.8	-97.7	-98.1
Interferer level dBm/6MHz					
Interferer ON	-50	100.00%	100.00%	100.00%	100.00%
	-49	100.00%	100.00%	100.00%	100.00%
	-48	100.00%	100.00%	100.00%	100.00%
	-47	100.00%	100.00%	100.00%	100.00%
	-46	100.00%	100.00%	100.00%	100.00%
	-45	100.00%	100.00%	100.00%	100.00%
	-44	100.00%	100.00%	100.00%	100.00%
	-43	100.00%	100.00%	100.00%	100.00%
	-42	100.00%	100.00%	100.00%	100.00%
	-41	100.00%	100.00%	100.00%	100.00%
	-40	100.00%	100.00%	100.00%	100.00%
	-39	100.00%	100.00%	100.00%	100.00%
	-38	100.00%	100.00%	100.00%	100 00%
	-37	100.00%	100.00%	100.00%	100 00%
	-36	100.00%	100.00%	100.00%	100 00%
	-35	100.00%	100.00%	100.00%	100 00%
	-34	99 826%	100.00%	99.90%	100 00%
	-33	99.477%	100.00%	98.80%	100 00%
	-32	98 910%	100.00%	97.50%	100 00%
	-31	97 600%	100.00%	96.40%	100 00%
	-30	96.073%	100.00%	95.60%	100 00%
	-29	**93.406%**	100.00%	**92.90%**	100 00%
	-28	**Test Stop**	100.00%	**85.40%**	100 00%
	-27		100.00%	**67.50%**	100 00%
	-26		100.00%	**50.50%**	100 00%
	-25		100.00%	**27.20%**	100 00%
	-24		100.00%	**Call Failure**	100 00%
	-23		100.00%		100 00%
	-22		100.00%		100 00%
	-21		100.00%		100 00%
	-20		100.00%		100 00%

REFSENS Settings @ Max Power 23dBm	DL Ch	5130	5800	5130	5800
	DL Ch Freq	741MHz	741MHz	741MHz	741MHz
	DL RB	50	50	50	50
	DL RB offset	0	0	0	0
	DL Modulation	QPSK	QPSK	QPSK	QPSK
	DL TBS	5	5	5	5
	UL Ch	23130	23800	23130	23800
	UL Ch Freq	711MHz	711MHz	711MHz	711MHz
	UL RB	5	5	5	5
	UL RB offset	45	45	45	45
	UL Modulation	QPSK	QPSK	QPSK	QPSK
	UL TBS	6	6	6	6
Cell BW [MHz]		10	10	10	10

APPENDIX A – REFERENCES

"CLIENT Test Methodology to Access Interference to Band Class 12 and 17 LTE Devices from Channel 51 Broadcasting," (July 11, 2012)

3GPP Technical Specification 36.521-1, "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: RF Conformance Testing"

3GPP Technical Specification 36.521-3, "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 3: Radio Resource Management (RRM) Conformance Testing"

3GPP Technical Specification 36.523-1, "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); User Equipment (UE) conformance specification; Part 1: Protocol Conformance Specification"

47 CFR Part 27, Code of Federal Regulations, Title 47, Telecommunication

END OF TEST REPORT

EXHIBIT C

Test Report: Assess Interference to Band Class 12 LTE Devices from Channel 51 Broadcasting

Index

Administrative Data

Testing Laboratory

Company: 7Layers, Inc.
Address: 15 Musick
Irvine, CA 92618
USA
Phone: 949-716-6512

Project Data

Report ID: VUS_ATT_1201_01
Responsible for testing and report: George Liu
Receipt of EUT: 5/3/2012
Date of Test(s): 7/13/2012
Date of Report: 7/15/2012

Applicant Data

Company Name: AT&T Services Inc.
Contact Person: Scott Prather, Joe Marx
Address: 1120 20th St NW, Suite 1000
Washington, CA 20036
E-mail: sp9162@att.com, jm7322@att.com

Manufacturer Data / DUT description

Band 12 LTE Tablet (Commercially Available from U.S. Cellular)
OUT: 00170B01

Test Equipment

Rohde and Schwarz TS8980FTANetOp

Name_of_Device	Type	Serial_Number
Rubidium Frequency Standard	MFS	1
CMW-500	CMW-500	100752
SMU200A Vector Signal Generator	SMU200A	103935 (Model No: 1141.2005k02)
AMU200A 1	AMU200A	100378 (Model No: 1402.4090k02)
Power Supply	NGMO2	100400
SMF100A Signal Generator	SMF100A	101321 (Model No: 1167.0000k02)
SSCU1 Inband Switching and Signaling Condition Unit	ISSCU-2x2 IP12	101224
SSCU2 Wideband Switching and Signaling Condition Unit	WSSCU-2x2 IP02	100714
MSCU1- F1, F4, F7, F13, F127	WSSCU-2x2 IP02	100714
FSQ-26 Signal Analyzer	FSQ-26	200844/026
NRP-Z21 Average Power Sensor	NRP-Z21	102328
Trigger	GV150-34	100100247
CS-PSSU Power Supply	CS-PSSU	100305 (Model No: 1126.7497.02)
SFE100 Test Transmitter 1	SFE100 (1)	121047 (Model No: 2112.4100K02)
SFE100 Test Transmitter 2	SFE100 (2)	121048 (Model No: 2112.4100K02)
SSCU2 Wideband Switching and Signalling Condition	WSSCU-2x2 IP02	100715
SMU200A Vector Signal Generator	SMU200A	104374
OSP - Open switch & control platform	OSP120	100148
CMW 500	CMW-500	106578
CMW 500	CMW-500	113628 (1201.0002K50.113628.QL)
AMU200A 2	AMU200A	100560 (Model No:

		1402.4090K02)
MSCU2 - F3,F8,F14,F7,F20	OSP120	100148
MSCU3 - F56,FF24,225,T38,T40	OSP120	100148
AMU200A 1	AMU200A	100525 (Model No: 1402.4090k02)
NRP-Z21 Average Power Sensor	NRP-Z21	100538
AMU200A 1	AMU200A	100xxx (Model No: 1402.4090k02)

Summary

The testing was performed in accordance to test plan titled “Test Methodology to Assess Interference to Band Class 12 and 17 LTE Device from Channel 51 Broadcasting” with the following exceptions.

- There are additional tests reported herein that assign 16 physical resource blocks (“PRBs”) to the downlink, rather than the full allocation of all 50 PRBs called for in “Test Methodology to Assess Interference to Band Class 12 and 17 LTE Device from Channel 51 Broadcasting”
- There are no Band 17 tests

Test Results

1.1 Channel 51 Interference to Band 12 User Equipment Operating in 700 MHz Blocks B and C, Full (50 PRBs) Downlink Allocation

Test purpose

This test is intended to determine whether the presence of a signal from Channel 51 will create a third-order intermodulation product which causes interference to a Band 12 UE receiving 50 PRBs in the 734-746 MHz “B” and “C” Blocks and transmitting 5 PRBs in the 710-716 MHz “C” Block.

Downlink Resource Block Allocation Details

Channel 5130

RBstart = 0

RBalloc = 50

Uplink Resource Block Allocation Details

Channel 23130

RBstart = 45

RBalloc = 5

1.1.3.1/2: DUT meets minimum conformance requirements for Section 7.3.3 for 36.521-1

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
22.8	23	19.3	25.7	-0.2	Inside

Trace : [00:02:19] Executing the measurement method ExecuteThroughputAckNackDtxLte ...

Test Step	Sub-frames	Samples	ACKs	NACKs	DTXs	Current Throughput	Total Throughput	Lower Limit	Interim Result
1	150	135	135	0	0	100.000 %	100.000 %	93.820 %	Inside

Pass/Fail Analysis According to 3GPP Specification:

Error Ratio	0.000 %
Relative Throughput Measured	100.000 %
Relative Test Limit	93.820 %
Relative Test Requirement	95.000 %
PASSED by	6.180 %

Test-Step Result: **Inside**

Test is performed again with parameter configured in accordance to Table 1.1.2

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.9	23	19.3	25.7	0.9	Inside

Trace : [00:02:19] Executing the measurement method ExecuteThroughputAckNackDtxLte ...

Test Step	Sub-frames	Samples	ACKs	NACKs	DTXs	Current Throughput	Total Throughput	Lower Limit	Interim Result
1	150	135	135	0	0	100.000 %	100.000 %	93.820 %	Inside

Pass/Fail Analysis According to 3GPP Specification:

Error Ratio	0.000 %
Relative Throughput Measured	100.000 %
Relative Test Limit	93.820 %
Relative Test Requirement	95.000 %
PASSED by	6.180 %

Test-Step Result: **Inside**

For both cases, output power is within 1 dB of the Power Class 3 power level of +23 dBm.

1.1.3.3 Establish actual reference sensitivity of DUT with criteria of 95% throughput

Downlink LTE signal power is lowered by 0.5 dB steps until 95% throughput criteria is met. This is the baseline for performance without interference.

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.4	23	19.3	25.7	0.4	Inside

Starting Eqidistant Measurement...

Search Step	Downlink Level in dBm	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	-93.3	0.0	1215	100.000	93.820	Inside
2	-93.8	0.5	1215	100.000	93.820	Inside
3	-94.3	1.0	1215	100.000	93.820	Inside
4	-94.8	1.5	1215	100.000	93.820	Inside
5	-95.3	2.0	1215	100.000	93.820	Inside
6	-95.8	2.5	1215	100.000	93.820	Inside
7	-96.3	3.0	1215	100.000	93.820	Inside
8	-96.8	3.5	1215	100.000	93.820	Inside
9	-97.3	4.0	1215	100.000	93.820	Inside
10	-97.8	4.5	1215	99.918	93.820	Inside
11	-98.3	5.0	1215	100.000	93.820	Inside
12	-98.8	5.5	1215	100.000	93.820	Inside
13	-99.3	6.0	1215	100.000	93.820	Inside
14	-99.8	6.5	1215	99.918	93.820	Inside
15	-100.3	7.0	1215	100.000	93.820	Inside
16	-100.8	7.5	1215	99.671	93.820	Inside
17	-101.3	8.0	1215	99.918	93.820	Inside
18	-101.8	8.5	1215	99.259	93.820	Inside
19	-102.3	9.0	1215	90.288	93.820	Outside

Measurement completed.

Actual REFSENS value is -102.3 dBm

OUT: 00170B01

1.1.3.5 Channel 51 DTV signal starts at -50 dBm / 6 MHz and shall be increased by 1 dB increments until Channel 51 power level reaches -20 dBm / 6MHz. Throughput percentage for each Channel 51 signal level shall be recorded.

REFSENS + 3dB = -99.3

Trace : [00:02:21] Setting DL power to -99.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:02:21] Setting DL power to -99.3 dBm. Expected uplink power 23.0 dBm.

Trace : [00:02:29] Switching ON interferer 1 at 695.000000 MHz to -50.0 dBm.

Search Step	Interferer Power Offset in dB	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	0.0	0.0	1215	99.918	93.820	Inside
2	1.0	1.0	1215	100.000	93.820	Inside
3	2.0	2.0	1215	100.000	93.820	Inside
4	3.0	3.0	1215	100.000	93.820	Inside
5	4.0	4.0	1215	100.000	93.820	Inside
6	5.0	5.0	1215	100.000	93.820	Inside
7	6.0	6.0	1215	100.000	93.820	Inside
8	7.0	7.0	1215	99.918	93.820	Inside
9	8.0	8.0	1215	99.918	93.820	Inside
10	9.0	9.0	1215	100.000	93.820	Inside
11	10.0	10.0	1215	99.918	93.820	Inside
12	11.0	11.0	1215	100.000	93.820	Inside
13	12.0	12.0	1215	99.753	93.820	Inside
14	13.0	13.0	1215	99.918	93.820	Inside
15	14.0	14.0	1215	99.177	93.820	Inside
16	15.0	15.0	1214	98.023	93.820	Inside
17	16.0	16.0	1214	97.199	93.820	Inside
18	17.0	17.0	1212	95.627	93.820	Inside
19	18.0	18.0	1215	95.062	93.820	Inside
20	19.0	19.0	1212	92.079	93.820	Outside
21	20.0	20.0	1210	86.942	93.820	Outside
22	21.0	21.0	1209	82.630	93.820	Outside
23	22.0	22.0	1202	67.055	93.820	Outside
24	23.0	23.0	1197	46.867	93.820	Outside
25	24.0	24.0	1172	24.915	93.820	Outside
26	25.0	25.0	1181	18.882	93.820	Outside
27	26.0	26.0	1161	12.231	93.820	Outside
28	27.0	27.0	1123	8.281	93.820	Outside
29	28.0	28.0	1093	11.802	93.820	Outside
30	29.0	29.0	1075	12.930	93.820	Outside
31	30.0	30.0	1094	12.340	93.820	Outside

Channel 51 DTV signal starts at -50.0 dBm / 6MHz and is increased by 1 dB. Throughput degradation begins at Channel 51 interferer level -31.0 dBm.

The test results are based on multiple power cycles, due to the device dropping the LTE radio link. When that occurred, the Channel 51 interferer was turned off and the device was restarted to allow it to reconnect to the LTE system. After the device re-established its LTE connection, the Channel 51 interferer was turned on at the level at which the LTE radio link dropped and the test continued. The process was repeated each time the LTE radio link was lost until the throughput measurements were obtained for Channel 51 signal levels up to -20 dBm.

Result:

- Actual QPSK REFSEN = -102.3 dBm / 10 MHz, OUT: 00170B01
- Actual Block B/C downlink REFSENS + 3 dB = -99.3 dBm
- Actual uplink power level in dBm/10 MHz at the UE antenna port when the DUT is commanded to operate at P_{UMAX} = 23.9 dBm
- Throughput degradation begins at a Channel 51 emulator power level of -31.0 dBm

1.3 Channel 51 Interference to Band 12 User Equipment Operating in 700 MHz Blocks B and C, Partial (16 PRBs) Downlink Allocation

Test purpose

This test is intended to determine whether the presence of a signal from a broadcast transmitter in Channel 51 will create a third-order intermodulation product which causes interference to a Band 12 UE receiving on 16 PRBs in the 734-746 MHz “B” Block and transmitting 5 PRBs in the 710-716 MHz “C” Block.

Downlink Resource Block Allocation Details

Channel 5130

RBstart = 0

RBalloc = 16

Uplink Resource Block Allocation Details

Channel 23130

RBstart = 45

RBalloc = 5

1.3.3.1 / 2: System is configured in accordance to Table 1.3.2, remaining parameters configured according to 36.521-1, Section 7.3.4.1 REFSENS measurement is performed.

Uplink Power Measurement:

Measured (dBm)	Nominal (dBm)	Lower Limit (dBm)	Upper Limit (dBm)	Deviation (dB)	Result
23.8	23	19.3	25.7	0.8	Inside

Trace : [00:02:21] Executing the measurement method ExecuteThroughputAckNackDtxLte ...

Test Step	Sub-frames	Samples	ACKs	NACKs	DTXs	Current Throughput	Total Throughput	Lower Limit	Interim Result
1	150	150	150	0	0	100.000 %	100.000 %	93.820 %	Inside

Pass/Fail Analysis According to 3GPP Specification:

Error Ratio	0.000 %
Relative Throughput Measured	100.000 %
Relative Test Limit	93.820 %
Relative Test Requirement	95.000 %
PASSED by	6.180 %

Test-Step Result: **Inside**

1.3.3.3 Set Band 12 downlink power to the level corresponding to REFSENS + 3dB. REFSENS, in this case, shall be the UE's actual REFSENS as measured in 1.1.3.3

Actual REFSENS value is -99.3 dBm (from 1.1.3.3)

OUT: 00170B01

1.3.3.4 Channel 51 emulator starts at -50 dBm / 6 MHz and shall be increased by 1 dB increments until Channel 51 power level reaches -20 dBm / 6MHz. Throughput percentage for each Channel 51 signal level shall be recorded.

REFSENS + 3dB = -99.3 dBm

Trace : [00:02:27] Setting DL power to -99.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:02:27] Setting DL power to -99.3 dBm. Expected uplink power 23.0 dBm.
Trace : [00:02:35] Switching ON interferer 1 at 695.000000 MHz to -50.0 dBm.

Search Step	Interferer Power Offset in dB	Margin in dB	Samples	Relative Throughput in %	Test limit in %	Interim Result
1	0.0	0.0	1350	100.000	93.820	Inside
2	1.0	1.0	1350	100.000	93.820	Inside
3	2.0	2.0	1350	99.926	93.820	Inside
4	3.0	3.0	1350	99.926	93.820	Inside
5	4.0	4.0	1350	100.000	93.820	Inside
6	5.0	5.0	1350	99.926	93.820	Inside
7	6.0	6.0	1350	100.000	93.820	Inside
8	7.0	7.0	1350	100.000	93.820	Inside
9	8.0	8.0	1350	99.926	93.820	Inside
10	9.0	9.0	1350	99.778	93.820	Inside
11	10.0	10.0	1350	98.889	93.820	Inside
12	11.0	11.0	1350	97.630	93.820	Inside
13	12.0	12.0	1350	96.000	93.820	Inside
14	13.0	13.0	1350	92.444	93.820	Outside
15	14.0	14.0	1350	84.889	93.820	Outside
16	15.0	15.0	1349	80.356	93.820	Outside
17	16.0	16.0	1350	78.667	93.820	Outside
18	17.0	17.0	1350	74.963	93.820	Outside
19	18.0	18.0	1348	69.881	93.820	Outside
20	19.0	19.0	1350	68.148	93.820	Outside
21	20.0	20.0	1349	59.081	93.820	Outside
22	21.0	21.0	1347	55.308	93.820	Outside
23	22.0	22.0	1349	38.399	93.820	Outside
24	23.0	23.0	1331	22.840	93.820	Outside
25	24.0	24.0	1320	11.515	93.820	Outside
26	25.0	25.0	1271	10.307	93.820	Outside
27	26.0	26.0	1274	7.849	93.820	Outside
28	27.0	27.0	1216	13.405	93.820	Outside
29	28.0	28.0	1195	14.979	93.820	Outside
30	29.0	29.0	1213	13.355	93.820	Outside
31	30.0	30.0	1178	17.657	93.820	Outside

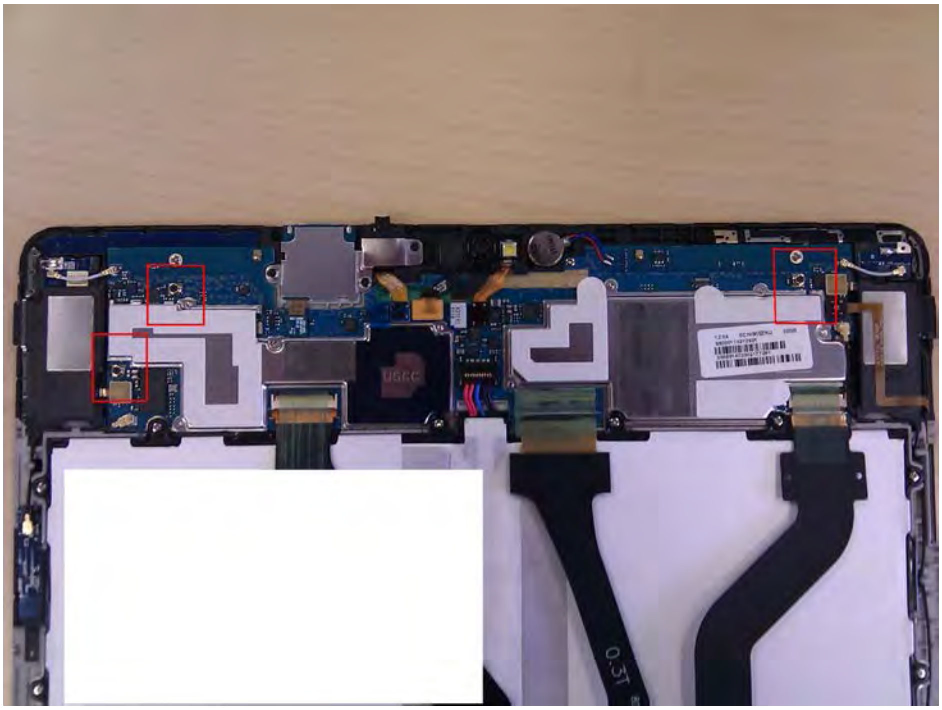
Channel 51 DTV signal starts at -50.0 dBm / 6MHz and is increased by 1 dB. Throughput degradation begins at Channel 51 interferer level -37.0 dBm.

The test results are based on multiple power cycles, due to the device dropping the LTE radio link. When that occurred, the Channel 51 interferer was turned off and the device was restarted to allow it to reconnect to the LTE system. After the device re-established its LTE connection, the Channel 51 interferer was turned on at the level at which the LTE radio link dropped and the test continued. The process was repeated each time the LTE radio link was lost until the throughput measurements were obtained for Channel 51 signal levels up to -20 dBm.

Result:

- REFSEN + 3dB power level utilized = -99.3 dBm / 10 MHz, OUT: 00170B01
- Actual uplink power level in dBm/10 MHz at the UE antenna port when the DUT is commanded to operate at P_{UMAX} = 23.8 dBm / 10 MHz
- Throughput degradation begins at a Channel 51 emulator power level of -37.0 dBm

Photographs



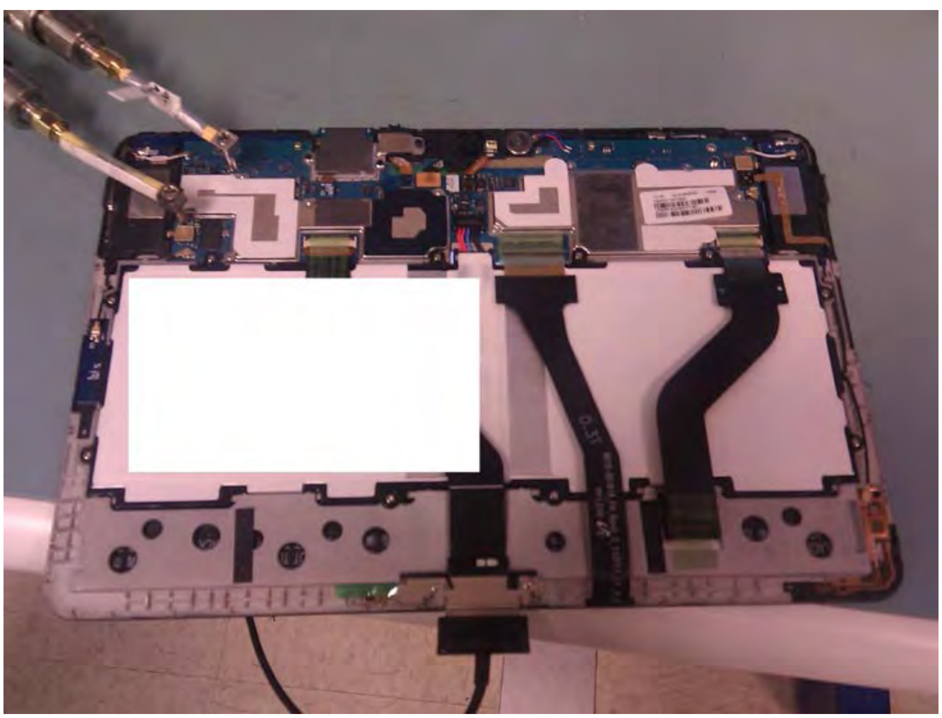



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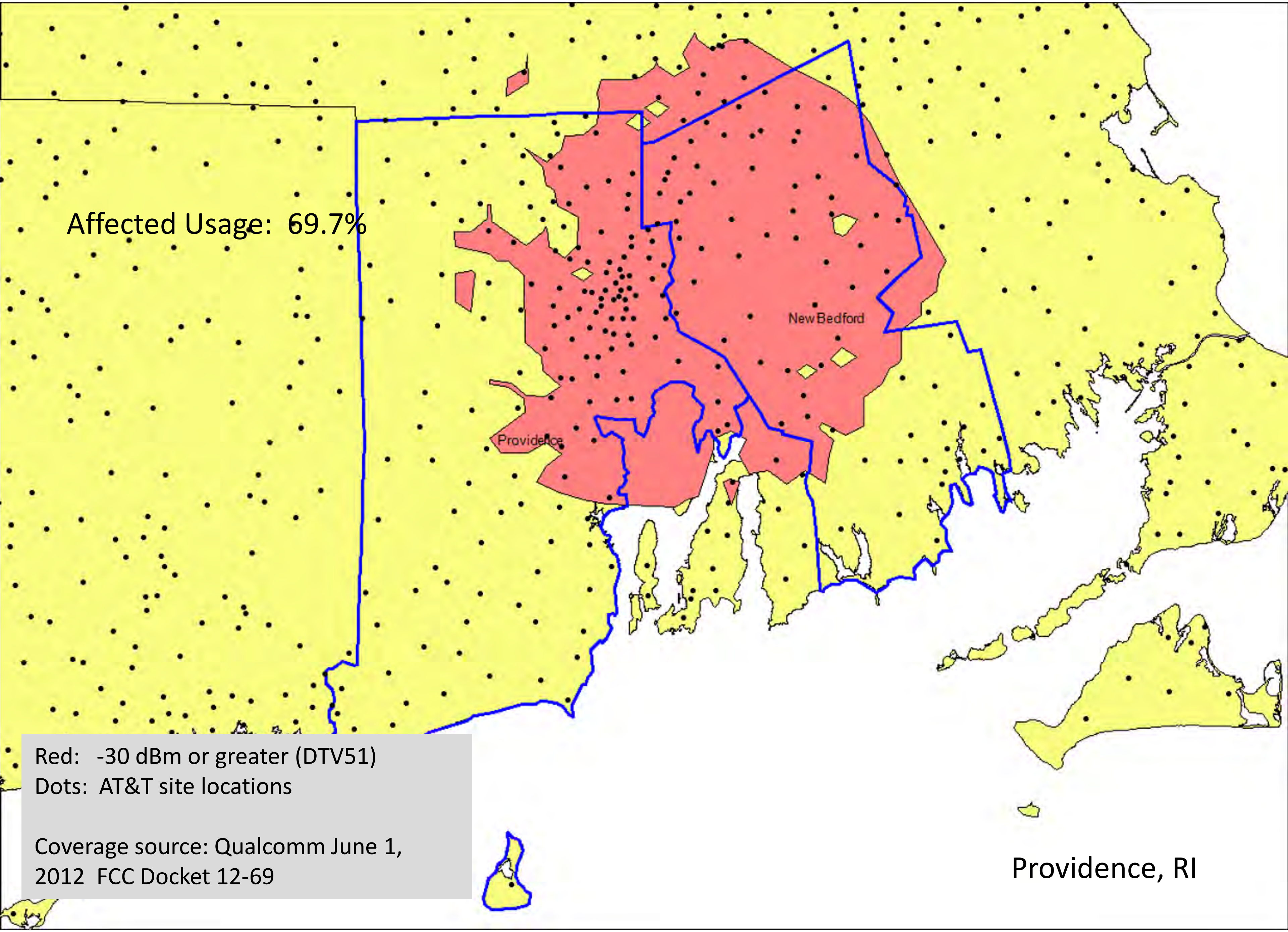
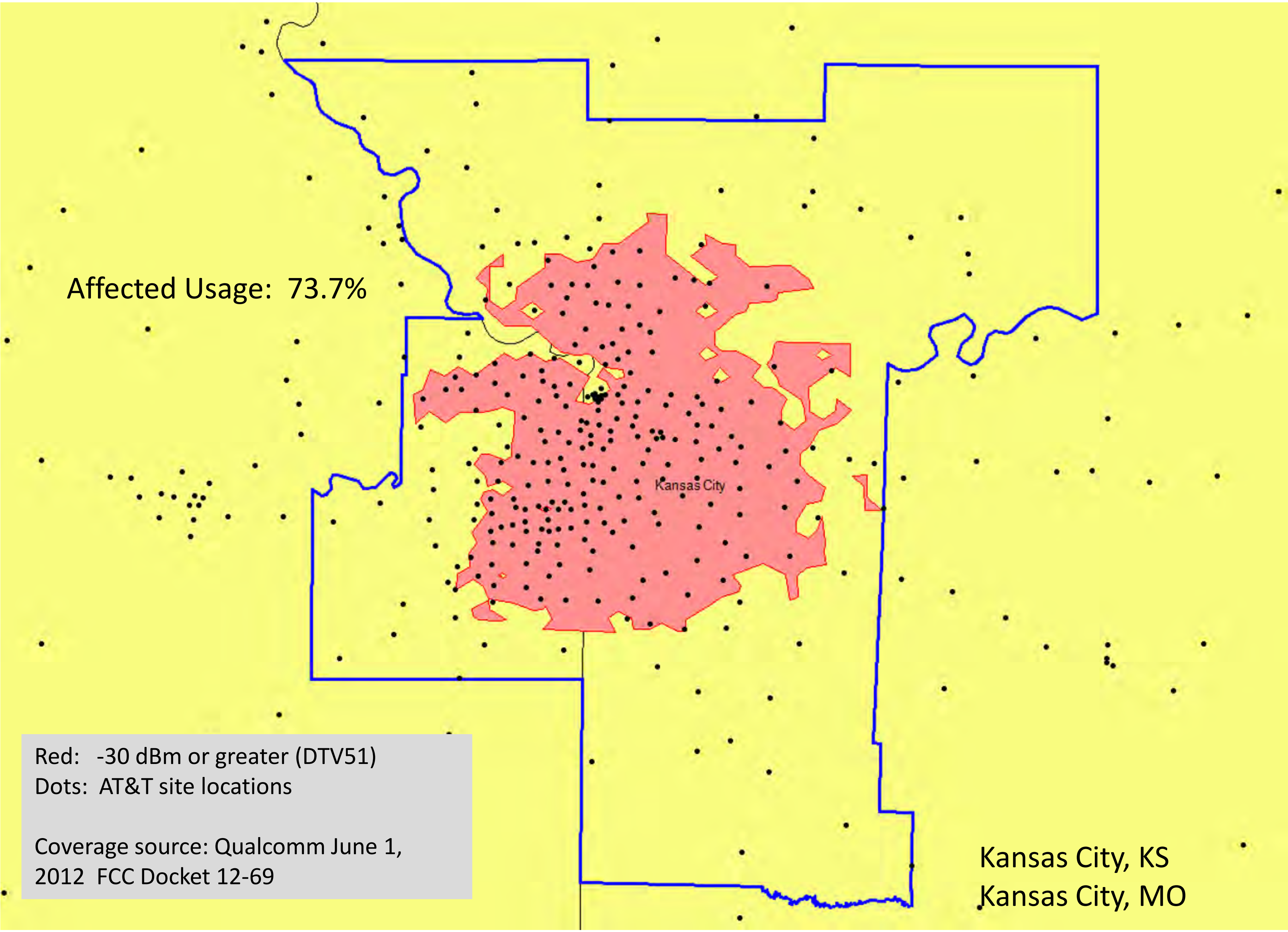
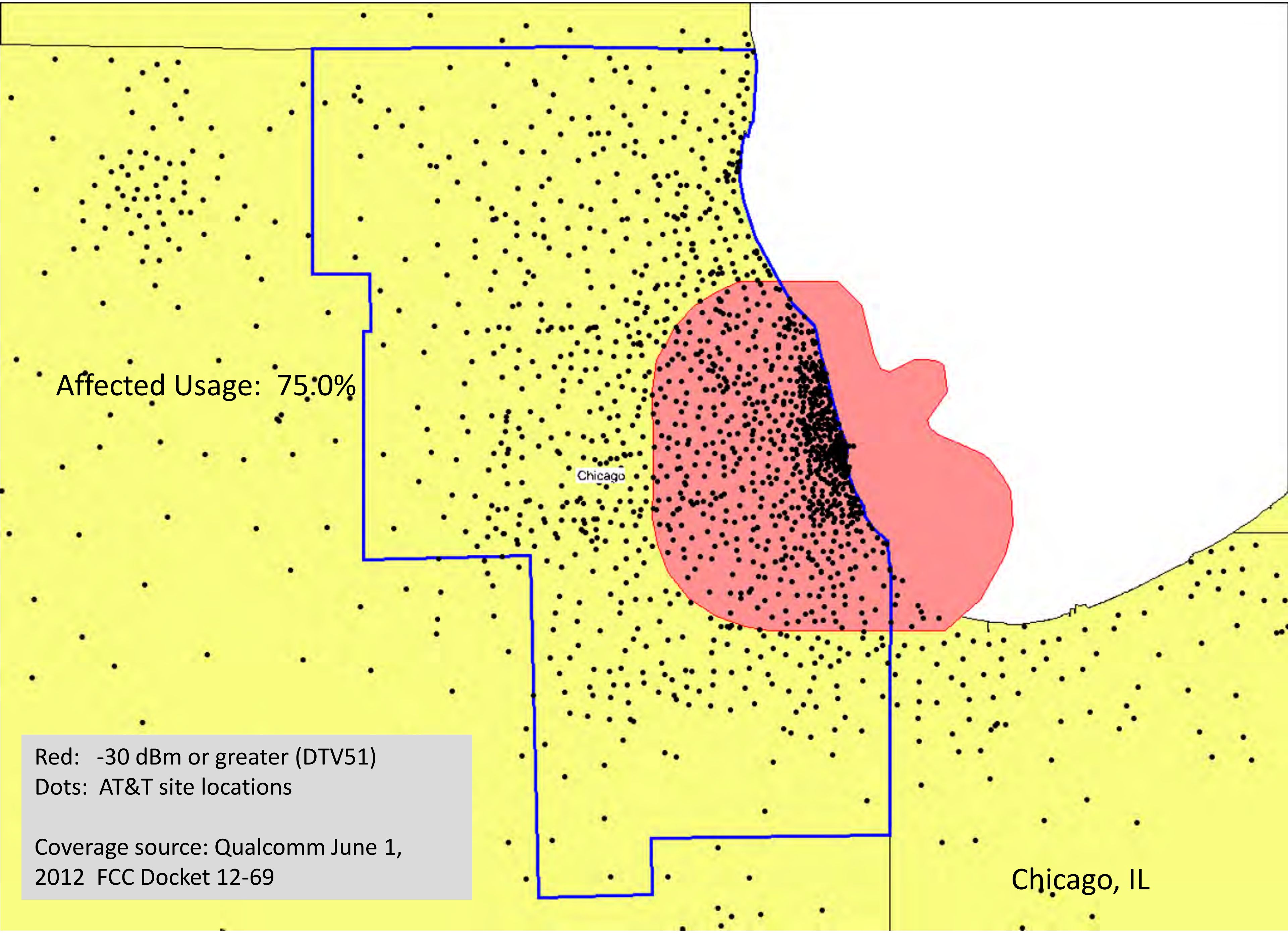
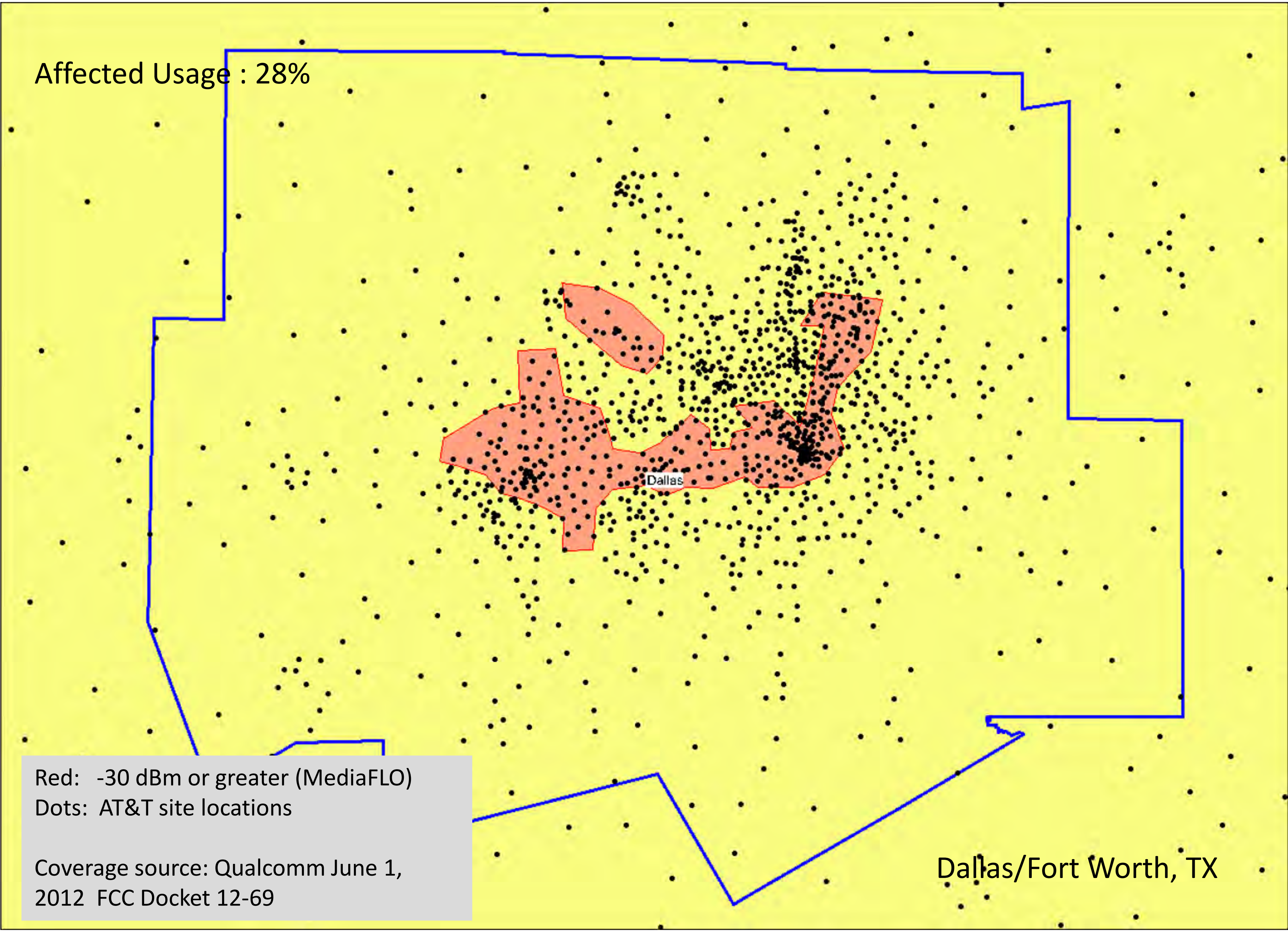
EXHIBIT D


Affected Usage: 69.7%
Providence
New Bedford
Red: -30 dBm or greater (DTV51)
Dots: AT&T site locations
Coverage source: Qualcomm June 1, 2012 FCC Docket 12-69
Providence, RI


Affected Usage: 73.7%
Kansas City
Red: -30 dBm or greater (DTV51)
Dots: AT&T site locations
Coverage source: Qualcomm June 1, 2012 FCC Docket 12-69
Kansas City, KS
Kansas City, MO


Affected Usage: 75.0%
Chicago
Red: -30 dBm or greater (DTV51)
Dots: AT&T site locations
Coverage source: Qualcomm June 1, 2012 FCC Docket 12-69
Chicago, IL



Affected Usage : 28%
Dallas
Red: -30 dBm or greater (MediaFLO)
Dots: AT&T site locations
Coverage source: Qualcomm June 1, 2012 FCC Docket 12-69
Dallas/Fort Worth, TX

ATTACHMENT B

Before The
Federal Communications Commission
Washington, DC 20554

In The Matter of	)	
	)	
Promoting Interoperability in the 700 MHz Commercial Spectrum	)	WT Docket No. 12-69
	)	
Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band	)	RM-11592 (Terminated)

REPORT OF MARK A. ISRAEL, MICHAEL L. KATZ, AND ALLAN L. SHAMPINE

July 16, 2012

Table of Contents

I. INTRODUCTION AND OVERVIEW

A. BACKGROUND

1. In 2008, the Federal Communications Commission (―Commission”) conducted Auction 73, through which it licensed the A, B and E Blocks in the lower 700 MHz spectrum band.[1] Auction 73 established a ―flexible use” policy for these blocks that did not mandate interoperability.[2] The result of this auction, in combination with AT&T’s 2008 acquisition of C Block licenses from Aloha Spectrum, was to make AT&T the primary holder of licenses for the B and C Blocks in the lower 700 MHz spectrum band.[3] In contrast, the A Block licenses are held primarily by Verizon Wireless, along with a variety of other carriers, some of which are participating in this proceeding.[4]

2. The 3rd Generation Partnership Project (―3GPP”)—the organization that sets the industry standards for Long-Term Evolution (―LTE”) wireless broadband technology—

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1 The lower C and D Blocks were previously auctioned in 2002. Commission auction website, *available at* http://wireless.fcc.gov/auctions/default.htm?job=auction_summary&id=73, site visited July 2, 2012; Federal Communications Commission, Notice of Proposed Rulemaking in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, FCC 12-31, March 21, 2012, (hereinafter *700 MHz NPRM*), ¶8.

2 *700 MHz NPRM*, ¶8; Federal Communications Commission, Second Report and Order, 22 FCC Rcd. 15289, August 10, 2007, ¶94; Federal Communications Commission, Report and Order in the Matter of Reallocation and Service Rules for the 698-746 MHz Spectrum Band, 17 FCC Rcd 1022, January 18, 2002, ¶¶1, 5, 13-15, 124, and 125; Federal Communications Commission, First Report and Order in the Matter of Service Rules for the 746-764 and 776-794 MHz Bands, and Revisions to Part 27 of the Commission’s Rules, 15 FCC Rcd 476, January 7, 2000, ¶¶1-2, 15, 18, and 31.

3 *700 MHz NPRM*, ¶4; Commission transaction website for AT&T Mobility and Aloha Spectrum license transfer, *available at* http://transition.fcc.gov/transaction/attmobility-alohaspectrum.html, site visited June 27, 2012.

4 Winning bids are listed by the Commission at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-08-595A2.pdf, site visited June 27, 2012.

set two different band classes for offering LTE service using lower 700 MHz spectrum. These band classes are known as Band Class 12 (“BC-12”), which covers operations in the A, B and C Blocks, and Band Class 17 (“BC-17”), which covers operations in the B and C blocks.[5] According to the 3GPP participants, it was necessary to create a separate BC-17 to avoid issues arising from potential interference from existing Channel 51 broadcasts and from possible deployments of high-powered services using the E Block.[6] Relying on the standards surrounding these two band classes, AT&T has begun deploying LTE over the lower 700 MHz B and C Blocks using BC-17, while United States Cellular Corporation (“US Cellular”) has started deploying in the A Block using BC-12.[7]

3. Recently, several parties have asked the Commission to force wireless carriers to abandon BC-17 and instead use BC-12. For example, RCA – The Competitive Carriers Association LLC (“RCA”) asks the Commission to set a date certain by which licensees of the lower 700 A, B, and C Blocks must utilize only BC-12-capable access devices.[8] Similarly, US Cellular calls for the requirement “that any mobile device designed to

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[5] We follow the Commission’s terminology and refer to each 3GPP LTE Operating Band as a “Band Class.” *700 MHz NPRM* at note 19.

[6] *700 MHz NPRM*, ¶¶7, 10.

[7] Declaration of Michael Prise (hereinafter *Prise Declaration*), attached to Comments of AT&T Services Inc. in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, June 1, 2012 (hereinafter *AT&T Comments*), ¶¶12, 18.

[8] Comments of RCA – The Competition Carriers Association LLC in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, June 1, 2012 (hereinafter *RCA Comments*), at 15.

RCA attempts to portray its proposal as relying on an industry solution, but, in fact, calls for the Commission to force an interoperability requirement on lower 700 MHz licensees. (*Id.* at 15 and 16.)

operate on lower 700 MHz A, B, or C Block spectrum be required to tune to all of these bands and support Band 12 as defined in 3GPP standards.”[9] Vulcan Wireless goes so far as to ask the Commission to require every lower 700 MHz licensee to: (i) have its base stations support BC-12 within six months of the Commission’s decision, (ii) offer at least one mobile device using BC-12 within nine months, and (iii) ensure that all of its mobile devices use BC-12 within 18 months.[10]

4. While expressing a preference for an industry solution, the Commission has also sought comment on imposition of a requirement that lower 700 MHz block licensees “use only mobile user equipment that has the capability to operate across all of these blocks.”[11] Licensees “would no longer be allowed to offer mobile units operating on Band Class 17” but “would substitute Band Class 17 with Band Class 12.”[12] Under the *700 MHz NPRM*’s proposal, existing BC-17 devices would be allowed to continue operating during a “reasonable transition period of no longer than two years.”[13]

B. Assignment and Summary of Findings

5. At the request of counsel for AT&T, we have analyzed the economic arguments made in filings submitted in this proceeding in support of the position that BC-17 should

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[9] Comments of United States Cellular Corporation in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69, June 1, 2012 (hereinafter *US Cellular Comments*), at 8. [Capitalization modified from original.]

[10] Comments of Vulcan Wireless LLC in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69, June 1, 2012 (hereinafter *Vulcan Comments*), at v. Vulcan’s proposal is “to support interoperability across the entire Lower 700 MHz band”. Currently, that means use of BC-12.

[11] *700 MHz NPRM*, ¶50.

[12] *700 MHz NPRM*, ¶50.

[13] *700 MHz NPRM*, ¶50.

be banned and that lower 700 MHz licensees should be forced to use BC-12.[14] Our analysis reveals that the central economic claims made by proponents of mandatory use of BC-12 overstate the competitive benefits and understate the significant risks to consumers from such a policy. Proponents of the BC-12 mandate seek to promote their private interests rather than any sound notion of the public interest.

6. Although proponents' stated rationale for imposing a BC-12 requirement is that doing so ―will help Lower A Block licensees obtain lower cost devices and equipment that meet consumer demands, enter into nationwide voice and data roaming arrangements, and deploy next-generation mobile service in their licensed areas,"[15] it is evident upon inspection that proponents actually are making the single (unsubstantiated) claim that they need to piggyback on AT&T in order to compete. In effect, the mandate's proponents argue that AT&T's *demand* for handsets utilizing lower 700 MHz spectrum and AT&T's lower 700 MHz B and C Block network are both essential facilities.[16] As we will explain below, the mandate's proponents offer no sound evidence to support this argument, and proponents ignore the costs that such a mandate might impose on consumers.

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14 We have not attempted to identify and analyze every argument raised by proponents of a BC-12 mandate. Rather we have focused on what appear to be the most significant arguments. The fact that an argument may have been raised without our discussing it below does not indicate that we support that argument.

15 *Vulcan Comments* at iv.

16 The mandate's proponents assert that they demand too few handsets to be able to realize production and/or purchasing economies of scale. These proponents argue that the mandate is necessary to allow them to piggyback their demand for handsets on top of AT&T's in order to achieve what these proponents assert is the necessary scale of purchases.

7. The *700 MHz NPRM*'s proposal is conditioned on the assumption "that interference concerns are reasonably addressed and the Commission is left with no other option . . . besides mandating mobile device interoperability. . . ."[17] It is not clear what the Commission means by "reasonably addressed." If the Commission means that: (a) there would be no risk that consumers would suffer from interference and lower-quality service, (b) there would be no risk that wireless telecommunications service providers would incur higher costs as a result of the mandate, and (c) all parties understood that the Commission would engage in this type of *ex post* imposition of standards only in circumstances in which there were no harms to consumers or service providers, then it would be a tautology that the mandate would have no costs. However, as we establish in the remainder of this report, such a scenario is entirely implausible, and couching discussion around these assumptions is not conducive to a careful evaluation of the facts and relevant economic policy considerations.

8. In reality, the Commission faces a situation in which a ban on use of BC-17 risks degrading service quality, raising costs, and creating investment-dampening uncertainty regarding future Commission actions. These concerns become even greater the shorter is the transition period for compliance with any mandate that is adopted. Any small gross benefits that the mandate might (in a best-case scenario) create would be more than offset by the risk of imposing significant costs on wireless consumers, including through the degradation of the quality of wireless service and/or slowing LTE deployment.[18]

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17 *700 MHz NPRM*, ¶50.

18 In discussing the balance of costs and benefits, it should be noted that we are *not* applying an antitrust standard. Under an antitrust standard, AT&T and any other users of BC-17 would not have to show that some measure of the social benefits of utilizing BC-17 outweighs social costs.

9. In summary, we find that:

- *Banning the use of BC-17 would substantially risk harming consumers by degrading service quality and/or slowing LTE deployment.* BC-17 was developed because of interference problems with Channel 51 and the lower 700 MHz E Block. Although the mandate's proponents assert that there would be no such interference problems, equipment manufacturers have submitted comments in this proceeding clearly contradicting this assertion. Banning the use of BC-17 would risk subjecting consumers to interference problems and/or increasing the cost of service, which could undermine LTE deployment. Moreover, it is not yet clear when, how, or if the Commission will be able to fully address Channel 51 and lower 700 MHz E Block interference concerns. Given the slowness and relative rigidity of regulatory proceedings and resulting rules, a mandate to utilize specific band classes and abandon others (especially while critical related factors are still evolving) runs a substantial risk that the regulatory "solution" will end up harming consumers and competition in comparison with alternative, more-flexible approaches.

- *Banning the use of BC-17 would have an adverse impact on consumers with existing BC-17 devices.* A BC-12 mandate would have a significant adverse impact on existing users of BC-17 devices. Proponents of the mandate contemplate "grandfathering" existing BC-17 devices for some period of time. However, current technology does not allow AT&T's network to support both BC-12 and BC-17 simultaneously. Hence, if AT&T were forced to offer service to new BC-12 devices, it could not simultaneously continue to offer service to existing BC-17 devices. A BC-12 mandate thus would strand existing consumer devices. Even if BC-17 devices could be updated to operate as BC-12 devices, the transition process would very likely lead to significant consumer inconvenience and service disruption. This is an important consideration because AT&T already has a BC-17 device base that numbers in the millions and is rapidly growing.

- *Banning the use of BC-17 could slow LTE deployment.* The forced use of BC-12 risks degrading quality for lower 700 MHz B and C Block networks, thus reducing incentives to deploy such networks. The forced use of BC-12 could also reduce deployment incentives by raising the costs of deploying LTE using the lower 700 MHz B and C Blocks in service areas that are potentially subject to interference from Channel 51 or lower 700 MHz E Block transmissions. In addition, the increased network costs triggered by the forced use of BC-12 instead of BC-17 would reduce incentives to expand LTE service within AT&T's existing LTE footprint in those areas where the marginal method of capacity expansion is to activate its network on its lower 700 MHz B and C Block licenses.

- *The mandate would harm wireless telecommunications services consumers by distorting competition.* AT&T is the primary holder of B and C Block licenses and has deployed a BC-17 network. The adverse effects on quality and LTE deployment would directly harm AT&T's wireless customers. By tilting the playing field and distorting competition, the ban would also indirectly harm customers of rival wireless carriers. Specifically, the ban's adverse quality and cost effects would weaken the competitive pressures that AT&T would bring to bear on rival wireless carriers, such as MetroPCS, Sprint, T-Mobile, US Cellular and Verizon Wireless, thus weakening rivals' incentives to provide high-quality services at low prices.

- *Eliminating the use of a specific standard after licensees and equipment suppliers already have made substantial investments in the standard and associated equipment will undermine future incentives to bid for licenses at auction and to invest in network infrastructure and handsets.* For sound reasons, the Commission's usual approach to interoperability is to specify whether interoperability will be required between bands prior to standards' being set and prior to investments' being made. Lower 700 MHz spectrum licenses were auctioned under flexible use rules that did not require interoperability and that allowed the use of BC-17. AT&T and manufacturers such as Qualcomm have made substantial investments in the development of BC-17 and in network infrastructure supporting BC-17. Banning the use of BC-17 would undermine the value of those investments. In the future, wireless carriers and equipment manufacturers making investment and auction plans could be expected to take the threat of future *ex post* changes by the Commission into account when deciding whether to make infrastructure investments and/or bid at auction for new licenses, thus reducing incentives to invest or to bid at auction.

- *A BC-12 mandate is not needed to ensure an adequate supply of BC-12-capable LTE handsets.* Proponents of a BC-12 mandate assert that such a mandate is needed to realize economies of scale in handset manufacture that will allow smaller carriers to attain handsets on terms that allow them to compete successfully. The fact that multiple smaller carriers have been able to obtain high-quality LTE handsets belies this claim. In part, this ability to obtain LTE handsets reflects the fact that smaller carriers enjoy scale benefits from riding on larger carriers' coattails even *absent* the mandate because, as proponents acknowledge, it is relatively easy to create BC-12 variants of LTE handsets that use other LTE bands. Moreover, effectively singling out AT&T for the mandate appears to be particularly inapt because AT&T uses GSM/UMTS "fall back" technology while A Block carriers primarily use CDMA. The differences between these two technologies make it more difficult to adapt AT&T handsets to a version the A Block carriers could use.

- *A BC-12 mandate is not needed to ensure roaming.* Proponents of the mandate could achieve roaming on a wide range of currently planned or deployed LTE networks by adopting multiband handsets. Multiband handsets are commonly used throughout the industry today, and the ability of handsets to operate on multiple bands is increasing due to industry investment and innovation. In any event, AT&T would not appear to be the preferred roaming partner for most lower 700 MHz A Block licensees because, as noted above, those licensees typically rely on CDMA, which is not compatible with AT&T's GSM/UMTS network.

10. The remainder of this report explains these findings in greater depth and provides details of the facts and analysis that led us to reach them.

II. THE PROPOSED MANDATE RISKS CAUSING SUBSTANTIAL, LONG-LASTING HARMS TO CONSUMERS.

10. The proposed mandate risks harming consumers in several different ways. In this section, we discuss each in turn. We then explain why these harms would be long-lasting.

A. A BC-12 MANDATE RISKS SUBSTANTIALLY HARMING CONSUMERS BY DEGRADING SERVICE QUALITY.

11. Wireless consumers care about network quality. As the Commission has noted, “network quality is a critical factor for many mobile consumers” and “network providers spend significant time and resources measuring network quality for purposes of improving and upgrading network performance.”[19] Network quality is widely recognized as an important determinant of customer churn, demonstrating that consumer welfare depends on network quality.[20]

12. Reflecting its importance, wireless carriers spend billions of dollars to improve network quality. For example, the Commission has noted that after iPhone users “experienced service quality problems on AT&T’s broadband network,” AT&T devoted

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[19] Federal Communications Commission, Fifteenth Report in the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services, WT Docket No. 10-133, FCC 11-103, June 27, 2011 (hereinafter *Fifteenth CMRS Report*), ¶222.

[20] Nokia Siemens Networks, for example, conducts annual customer acquisition and retention surveys and has found quality to be a key driver of churn. In February 2012, Nokia Siemens Networks reported that dissatisfaction with mobile broadband quality was the primary reported cause of churn. http://www.nokiasiemensnetworks.com/news-events/press-room/press-releases/dissatisfaction-with-mobile-broadband-key-driver-for-changing-operator-mwc12, site visited June 28, 2012.

the majority of its capital spending to various measures aimed at upgrading and expanding the capacity of its 3G network in order to fix these problems. . . ."[21]

13. Consistent with the focus on service quality, participants in the standard-setting process indicate that BC-17 was developed because of concerns that interference from Channel 51 and the lower 700 MHz E Block would degrade service quality.[22] We are not engineers, and we do not attempt to resolve the conflicting claims made regarding interference concerns. We do note, however, that there appears to be agreement that: (a) interference concerns are real, and (b) they are serious enough to deter lower 700 MHz A Block licensees from deploying service in much of the country.[23] Interference concerns for the lower 700 MHz B and C Blocks may be smaller than for the A Block (the debate is primarily about how much smaller), but even if they are substantially smaller, they could remain quite significant from a consumer perspective. The marketplace evidence is that the concerns have been serious enough to motivate multiple manufacturers (*e.g.*, Motorola and Qualcomm) to research, develop, and implement solutions. In a related

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[21] Federal Communications Commission, Fourteenth Report in the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services, WT Docket No. 09-66, FCC 10-81, May 20, 2010 (hereinafter *Fourteenth CMRS Report*), ¶224.

[22] Comments of Qualcomm Incorporated in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, June 1, 2012 (hereinafter *Qualcomm Comments*), at 3.

[23] See, for example, Comments of Cricket Communications, Inc. in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, June 1, 2012 (hereinafter *Cricket Comments*), at 10 to 12.

cautionary tale, failure to account for interference risks can lead to situations such as LightSquared's GPS-interference-related bankruptcy.[24]

14. Qualcomm has submitted evidence –that consumer devices operating on the Lower B and/or C blocks using the Band 12 filter will suffer harmful interference from E Block and Channel 51 signals, while the Band 17 filter provides these devices with an effective defense."[25] Although there is certainly debate about the extent of the likely impact, Qualcomm's submitted tests indicate that the impact may be substantial and widespread:[26]

> As Qualcomm's analysis demonstrates, consumer device performance will be detrimentally affected, sometimes devastatingly so, in regions where E Block or Channel 51 operations are present. This degradation, although localized for a given E Block or Channel 51 transmitter, is likely to occur in many regions of the country and is likely to significantly affect customers as they travel around the country, and requiring operators to use Band 12 devices would condemn Band 17 devices to inferior service and dropped calls.

AT&T also expressed an expectation of –reduced performance – lower throughput, a higher risk of blocked or dropped connections and less overall spectrum capacity to serve customers."[27] Motorola has made similar points.[28]

15. The extent of Channel 51 broadcasts that may generate interference can be seen through the A Block exclusion zones that the Commission has imposed around such

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24 LightSquared press releases *available at* http://www.lightsquared.com/press-room/press-releases/lightsquared-implements-voluntary-chapter-11-restructuring/, site visited June 22, 2012.

25 *Qualcomm Comments* at 4.

26 *Qualcomm Comments* at 65.

27 *AT&T Comments* at 7.

28 Comments of Motorola Mobility, Inc. in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, WT Docket No. 12-69, June 1, 2012 (hereinafter *Motorola Comments*) at 2 and 3.

broadcasts. There are many such zones and they cover a variety of major population centers.[29] AT&T has already deployed LTE service using Lower 700 MHz B and C Blocks in several areas subject to interference from Channel 51 broadcasts.[30] AT&T has also commissioned studies by two testing firms that have now shown empirically that BC-12 handsets experience reduced throughput and dropped calls due to Channel 51 interference while BC-17 handsets do not.[31]

16. Interference to a BC-12 network and associated access devices from lower 700 MHz E Block service is potentially even more widespread, as those licenses cover the entirety of the United States.[32] Many of those licenses are held by DISH Network, which has expressed the intent to deploy a high-powered broadcast wireless service.[33]

17. In summary, banning the use of BC-17 and mandating use of BC-12 devices that are less capable of handling Channel 51 and E Block interference would subject AT&T's customers to lower quality due to interference problems. In addition to harming AT&T customers directly, requiring AT&T to use less-capable devices would make AT&T a

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29 See map of Channel 51 protected areas provided by Bill Stone of Verizon at the Commission's 700 MHz Interoperability Workshop, *available at* http://transition.fcc.gov/presentations/04262011/bill-stone.pdf, site visited June 22, 2012.

30 Jeffrey H. Reed and Nishith D. Tripathi, ―Supplemental Analysis: Impact of Channel 51 and E Block Interference on Band 12 and Band 17 User Equipment Receivers," July 16, 2012 (hereinafter *Reed and Tripathi Supplemental Analysis*), §2.3.

31 The results of the tests conducted by PCTEST and 7 layers are reported in *Reed and Tripathi Supplemental Analysis*, Executive Summary and §2.1.C.

32 AT&T holds five of those licenses and has agreed to limitations on their use to address interference concerns. Other license holders are still allowed to offer high-power broadcasts. (*AT&T Comments* at 30, 31 and 49.)

33 Comments of DISH Network Corporation in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, June 1, 2012 (hereinafter *DISH Network Comments*), at 2, 3 and 5.

weaker competitor, harming customers of other wireless carriers as well. In short, forcing carriers to abandon BC-17 would be a dangerous experiment.

B. BANNING USE OF BC-17 WOULD HAVE AN ADVERSE IMPACT ON CONSUMERS WITH EXISTING BC-17 DEVICES.

18. A BC-12 mandate would also have a significant adverse impact on existing users of BC-17 devices. Proponents of the mandate contemplate ―grandfathering" existing BC-17 devices for some period of time.[34] However, current technology does not allow AT&T's network to support both BC-12 and BC-17 simultaneously. Hence, if AT&T offered service to new BC-12 devices, it could not simultaneously continue to offer service to existing BC-17 devices, thus eliminating the value of the grandfathering provision in *700 MHz NPRM's* proposed mandate.[35] An abrupt change risks stranding millions of consumer devices.[36]

19. Proponents of the mandate have suggested that existing BC-17 devices can be converted to BC-12 devices through remote software updates.[37] AT&T disputes this claim, noting that: (a) no such capability exists today; (b) it is unclear if, when, and at what cost it could be developed; (c) even if feasible, any such transition would cause substantial service disruptions; and (d) even if a BC-17 device could potentially be altered to accept some BC-12 signals, it would not be a BC-12-standards-compliant device, and would fail to operate on a variety of BC-12 networks (*e.g.*, any BC-12

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34 *Vulcan Comments* at 40. *NPRM,* ¶50.

35 *AT&T Comments* at 6.

36 *Prise Declaration*, ¶12.

37 *Vulcan Comments* at 38.

network with a lower 700 MHz A Block component).[38] The unprecedented nature and extent of the change, and the fact that it would be implementing an untested version of BC-12 outside of the standard, indicate that this would be a risky endeavor with the potential for many consumers to wind up with nonfunctional devices.[39]

C. THE PROPOSED MANDATE COULD DISCOURAGE LTE DEPLOYMENT.

20. Information Age Economics (―IAE”) asserts (entirely hypothetically) that, if failure to mandate lower 700 MHz interoperability reduced broadband penetration nationally by one percent, then it would result in slower business creation and expansion and cost the government billions of dollars per year in lost tax revenues.[40] IAE provides absolutely no basis for the one-percent figure and no basis for converting this into economic harm.[41]

21. In fact, IAE has the argument exactly backward. Forced use of BC-12 risks degrading quality for the lower 700 MHz B and C Block networks, thus reducing incentives to deploy such networks and likely reducing adoption of the service due to the lower quality. The forced use of BC-12 could also substantially raise the costs of

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[38] Reply Declaration of Michael Prise and Jeffrey Howard, in the Matter of Promoting Interoperability in the 700 MHz Commercial Spectrum, Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band, WT Docket No. 12-69, July 16, 2012, ¶¶26-42. Prise and Howard provide a detailed discussion of the various problems associated with remote software updates, including the fact that ―non-stock devices” (*i.e.,* LTE-compatible modules that third parties place in devices such as laptop computers and set top boxes) are not configured to accept remote software updates that change band classes.

[39] *Id.,* ¶42.

[40] Martyn Roetter, Alan Pearce and Barry Goodstadt, ―Non-Interoperability at 700 MHz: Lower Revenues & Higher Prices,” November 2011, Information Age Economics (hereinafter *IAE Report*) at 5. See also *Vulcan Comments* at 24 and 25.

[41] Amazingly, IAE states that it will provide sources (and, presumably, their calculations and methodology) at some unspecified date in the future. *IAE Report* at 2.

deploying LTE in the lower 700 MHz B and C Blocks. In particular, mandatory use of BC-12 could force a carrier to construct a more costly network with more cell sites, as well as cell sites in otherwise inefficient locations, in order to mitigate some of the interference effects associated with the use of BC-12 instead of BC-17.[42] Mandatory use of BC-12 could also force a network to operate using less-efficient modulation schemes.[43] If so, the effect would be to increase the costs of providing a given level of capacity. For new deployments, these network costs would be incremental costs. Hence, the higher cost levels would discourage LTE deployment in areas that currently do not have LTE and are potentially subject to interference from Channel 51 or lower 700 MHz E Block transmissions.

22. In addition, the increased network costs triggered by the forced use of BC-12 instead of BC-17 would reduce incentives to expand LTE service within AT&T's existing LTE footprint. This effect would arise because AT&T would face higher costs of expanding its LTE capacity where the marginal method of capacity expansion is to activate its network on its lower 700 MHz B and C Block licenses. Costs would be higher because using BC-12 would require installing and operating a greater number of cell sites to attempt to provide a level of quality equal to that achieved with the use of BC-17, if that level could be achieved at all.[44]

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42 *AT&T Comments* at 8; Declaration of David Wolter, attached to *AT&T Comments*, ¶¶40-52; *Reed and Tripathi Supplemental Analysis,* §3.3.

43 *Reed and Tripathi Supplemental Analysis,* §1. It would be unfortunate, to say the least, for the Commission to force the use of less efficient modulation schemes at a time when the Commission has recognized a spectrum shortage and has encouraged wireless carriers to use spectrum as efficiently as possible.

44 *AT&T Comments* at 32 and 33.

23. Clearly, the reduction in the scope and depth of AT&T's network would be expected to reduce the welfare of AT&T's customers. It should also be recognized that a mandate that raised AT&T's costs and reduced its capacity would make AT&T a weaker competitor and, thus, harm customers of other wireless carriers as well.

D. The Proposed Mandate would Undermine Future Incentives to Invest in Networks and Bid in Spectrum License Auctions

24. Adverse effects on current incentives to deploy LTE are not the only mechanism through which the proposed mandate would harm investment. The *700 MHz NPRM*'s proposal would force AT&T to adopt BC-12 and cease its operations in BC-17. AT&T and manufacturers such as Qualcomm have already made substantial investments in BC-17. In addition to the direct costs to the industry of having to undertake multiple transitions, the mandate would harm investment and innovation through several other mechanisms. Most fundamentally, eliminating the use of a specific standard after licensees and their suppliers already have made substantial investments in the standard and associated equipment will undermine future incentives to invest in network infrastructure and handsets, as well as undermine future incentives to bid at auction for spectrum licenses.

25. Consider first the mechanisms by which investment and innovation in infrastructure and handsets would be harmed. One is that undermining the use of an established industry standard would undermine the central role of industry standards as a means of coordinating an economic ecosystem so that various parties can make

complementary investment decisions. As the Department of Justice and Federal Trade Commission have noted:[45]

> Industry standards are widely acknowledged to be one of the engines driving the modern economy. Standards can make products less costly for firms to produce and more valuable to consumers. They can increase innovation, efficiency, and consumer choice; foster public health and safety; and serve as a "fundamental building block for international trade." Standards make networks, such as the Internet and wireless telecommunications, more valuable by allowing products to interoperate.

Undermining the BC-17 standard would block the realization of many of these benefits.

26. A second mechanism by which investment and innovation would be harmed is through the increased uncertainty that the mandate would create. AT&T and equipment manufacturers have made substantial investments in the development of BC-17 and the roll out of network infrastructure supporting BC-17. Banning the use of BC-17 would undermine those investments. Wireless carriers and manufacturers can be expected to take the threat of future Commission *ex post* changes (*i.e.,* changes made after companies have made sunk investments based on the regulatory regime existing at the time) into account when deciding whether to make new investments in infrastructure and handsets. When industry participants observe firms investing based on one set of regulations and then incurring significant losses due to a change in regulation, industry participants can be expected to revise upward their expectations of regulatory uncertainty and the risk that future regulatory changes will undermine investments. The uncertainty created by the Commission's actions thus could be expected to reduce incentives to innovate and invest.

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[45] U.S. Department of Justice and the Federal Trade Commission (2007), *Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition*, at 33. [Internal citations omitted.]

This harm is of particular concern because the industry is changing rapidly and firms are continually investing in new generations of technology and deploying new networks.

27. When a regulator establishes a reputation for changing its policies *ex post*, investment is likely to decline in response because firms recognize that there is a substantial probability their investments will be rendered less profitable by future regulatory actions. The adverse impact of regulation-induced uncertainty on private investment has been identified and studied by the regulatory economics literature for many years. For example, Thomas Hazlett and Matthew Spitzer have found that the Commission's repeated reversals of its policies during the reregulation of the cable industry in the 1990s created ―a large degree of regulation-induced uncertainty" which resulted in substantial reductions in investment.[46] Similarly, Paul Levine, John Stern and Francesc Trillas have noted that ―awareness by private investors of this regulatory risk drives up the required rate of return and the cost of capital. The latter dramatically reduces investment as has been seen in many countries. . . ."[47]

28. Policy changes made on the basis of the self-interested claims of parties that offer little and/or faulty evidentiary support for their claims are of particular concern as such changes: (a) increase the expected probability that *ex post* changes will be made in the future (because the bar has been set so low); (b) make it especially difficult for industry participants to predict which *ex post* changes will occur in the future (because industry

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[46] Thomas W. Hazlett and Matthew L. Spitzer (1997), *Public Policy Toward Cable Television: The Economics of Rate Controls*, Cambridge, MA: The MIT Press and Washington, DC: The AEI Press, at 160-161 and 173-175.

[47] Paul Levine, John Stern and Francesc Trillas (2005) ―Utility price regulation and time inconsistency: comparisons with monetary policy" *Oxford Economic Papers*, **57:** 447-478, at 449, citing B. Levy and P. Spiller (eds) (1996) *Regulations, Institutions and Commitment*, Cambridge University Press, Cambridge.

participants cannot rule out the possibility of future *ex post* changes made on the basis of any number of weak and unsubstantiated claims); and (c) demonstrate that the policymaker is susceptible to rent-seeking activities, triggering a perverse feedback loop of increasing rent seeking. The feedback loop arises because adopting policies requested by parties to promote their private interests while providing no credible evidence of public-interest benefits sends a signal to industry participants that there are positive expected returns to engaging in this type of rent-seeking activity. Hence, firms will be encouraged to engage in additional rent seeking. The economics literature has clearly identified the substantial harms to efficiency and—especially—innovation that arise when rent-seeking activities are perceived as profitable.[48]

29. We understand that there is a debate about whether the Commission has the legal authority to impose the proposed mandate,[49] but from an economic perspective, the Commission's ability to impose the mandate at any time is largely irrelevant. Even assuming that the Commission has the authority to make such a change, and that all licensees were aware of that authority before investing in their networks, the licensees' investment incentives depend on the Commission's reputation (*i.e.,* what licensees expect the Commission to do), which is based on what the Commission actually does, not what it could do. If the Commission adopts the proposed mandate, it will be sending a signal that it is possible to engage in successful rent-seeking activities aimed at changing regulation/standards after the fact to gain competitive advantage. Doing so will be

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48 See, for example, Kevin M. Murphy, Andrei Shleifer and Robert W. Vishny (1993) ―Why Is Rent-Seeking So Costly to Growth?" *The American Economic Review,* **83**(2), Papers and Proceedings of the Hundred and Fifth Annual Meeting of the American Economic Association, 409-414.

49 *AT&T Comments* at 37.

especially harmful because: the mandate undermines an established industry standard; the mandate would be an *ex post* policy change; and the mandate's proponents have made a very weak case for it. Alternatively, the Commission could reject the mandate, which would further the Commission's reputation for acting consistently over time and resisting attempted rent-seeking, and thus would encourage future productive investment and innovation.

30. Similar considerations apply to bidding at future spectrum license auctions. Professor Peter Cramton and IAE claim that eliminating BC-17 and requiring use of BC-12 will increase revenues from future spectrum auctions by many billions of dollars.[50] As with IAE's claim regarding employment effects, this claim is exactly backwards. Professor Cramton correctly points out that changes in the rules after an auction is over can have adverse effects on bidding in future auctions. But he then mistakenly asserts that banning the use of BC-17 would be in keeping with the rules of the original auction. The Commission has always clearly stated whether interoperability will be required or not, and lower 700 MHz spectrum licenses were auctioned under rules that allowed for “flexible use” and did not mandate either interoperability or use of BC-12.[51] By way of contrast, the Commission did require interoperability with respect to cellular spectrum.[52] Forcing interoperability *ex post* would be a “bait and switch” and would raise regulatory uncertainty about future investments. There is no basis to assume that retroactively mandating the use of BC-12 through the current proceeding will have any positive effect

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[50] *IAE Report* at 4. Peter Cramton, “700 MHz Device Flexibility Promotes Competition,” August 9, 2010 (hereinafter *Cramton Report*), at 9.

[51] *Op cit.* 2.

[52] *700 MHz NPRM*, ¶17.

on future auctions.[53] Instead, mandating the use of a specific standard after licensees already have made substantial investments will undermine future incentives to bid for licenses at auction and to invest in building out wireless networks utilizing those licenses.

E. THE HARMS IDENTIFIED IN THIS SECTION WOULD BE LONG LASTING

31. It is important to recognize that a regulatory mandate risks imposing *long-lasting* harms on consumers. Concerns with interference from Channel 51 and lower 700 MHz E Block transmissions were sufficiently serious that equipment manufacturers and wireless carriers researched, developed, and implemented BC-17 as an alternative to using BC-12 for the lower 700 MHz B and C Blocks. If the Commission mandates use of BC-12 and those interference concerns are not adequately addressed by some other means, there is no ready escape clause available to the industry. AT&T, Qualcomm and others would be stuck using BC-12 even if BC-17 were revealed by market experience to be far superior. The Commission might reverse course yet again, but, as with this proceeding, that would take time. Given the inherently slow pace of regulatory proceedings, consumers would be subjected to interference and lower service quality for many months, if not years. Regulatory proceedings, by their nature, are slow and inflexible. The industry standard-setting process, in contrast, allows engineers and industry professionals to engage in ongoing discussions of engineering issues to address industry concerns in a consensus-driven fashion that allows frequent and timely updates and changes within the overall framework of the standard.

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53 IAE argues that mandatory interoperability will make it feasible for additional parties to obtain handsets at low cost, thus raising the number of bidders participating in spectrum auctions and increasing the equilibrium winning bids. (*IAE Report* at 3 and 4.) As discussed elsewhere in our report, the claim that smaller carriers need the BC-12 mandate in order to obtain handsets at low cost is unfounded.

32. Moreover, by the time the market experience became clear and the Commission reversed course, consumers, carriers, and equipment manufacturers would surely have made sunk investments in non-BC-17 handsets and network infrastructure. Consequently, there would be a need for a second transition in order to reintroduce BC-17. Transitions take time, which means consumers would continue to suffer from interference (in addition to having to bear various transition costs).

33. The need to switch technologies yet again also would trigger another round of stranded investment. As discussed in the earlier parts of this section, the resulting harms to future investment and innovation, as well as to revenues from future spectrum license auctions, would last far beyond any transition period. These harms would arise from the uncertainty created by the Commission's repeatedly changing the rules after carriers had made sunk investments. Harms would also arise from the increased incentives to engage in socially unproductive rent seeking. It should also be recognized that the harms from regulatory uncertainty and increased rent seeking would arise and be long-lasting even if it did not turn out to be necessary to reverse an initial BC-17 ban. Imposition of that ban alone would be enough to trigger damaging, long-lived reputation effects.

34. Lastly, there is another way in which the mandate would harm innovation and, thus, impose long-term harms on consumers. As discussed below, the industry is working on technological advances that will increase firms' options for roaming and dealing with interference issues. A regulatory mandate locking-in a particular approach today (*e.g.,* BC-12) would undermine incentives to continue to evolve potentially superior technologies.

III. THE PROPOSED MANDATE DOES NOT GENERATE SIGNIFICANT EXPECTED BENEFITS.

35. Given the costs identified above, the Commission should be very cautious about banning the use of BC-17 and forcing the use of BC-12. A necessary (but not sufficient) condition for such a policy to be welfare enhancing would be the presence of large expected benefits. In fact, the expected gross benefits—that is, the benefits even without considering the offsetting costs—are small or non-existent.

A. THE PROPOSED MANDATE IS NEITHER NECESSARY NOR PARTICULARLY USEFUL AS A MEANS FOR LOWER 700 MHZ A BLOCK CARRIERS TO GAIN ECONOMIES OF SCALE

36. Proponents of a BC-12 mandate rely on arguments regarding claimed economic benefits that do not survive scrutiny. Proponents claim that they pay higher prices for phones than do larger carriers and that interoperability would lead to lower prices for them.[54] Proponents claim, in particular, that, if AT&T were required to use BC-12, then they would be able to take advantage of AT&T's purchase volumes to attain economies of scale for their own handset purchases and, thus, obtain handsets at lower cost. However, proponents are already able to obtain such scale benefits because, as proponents acknowledge, it is relatively easy to create BC-12 versions of handsets that operate in other LTE bands. In fact, such handsets are already available. Moreover, as we discuss in the next section, proponents of a BC-12 mandate would not be able to use the same devices manufactured for AT&T even if AT&T did switch to BC-12 because, for example, AT&T's LTE devices also operate on AT&T's GSM/UMTS networks,

[54] See, for example, *Cricket Comments* at 7.

whereas the BC-12 proponents typically need devices that will work on their existing CDMA networks.[55]

1. Converting LTE handsets to a new band class is relatively simple.

37. The initial implementation of a band class involves substantial effort in designing and testing the relevant software and hardware, including chipsets and network equipment.[56] However, once that effort has been undertaken, there appears to be agreement that the handset components needed to ―adapt” a handset for a different LTE band are quite inexpensive and the process for creating variants of a handset using different band combinations is straightforward. As one of the proponents of the mandate, Vulcan Wireless, has asserted:[57]

> In future LTE devices, manufacturers need only replace the Band Class 17 software with Band Class 12 and effectuate a small widening in the duplexer to support the Lower A, B and C Blocks, leaving the device architecture otherwise unchanged. There would be no increase in the number of bands to support, and no new power amplifiers, switches, or filters to incorporate in the device. These device modifications could be implemented within a few months…

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[55] We also note, in passing, that proponents' claims regarding handset economies of scale are undermined by the following statement from MetroPCS's CEO:

> Driving customers to this network will be motivated by an increase in 4G LTE smartphone choice. Handset OEMs worldwide are responding and recently, the Global Mobile Suppliers Association announced the number of LTE-enabled handsets is growing rapidly. From June 2011 to January 2012, on a global basis, the *number of LTE-enabled devices surged six-fold to approximately 269*. Production is widespread, as devices were manufactured by *57 companies*. Additionally, it was reported that approximately 49 operators globally have launched LTE networks. Clearly, this is a *global movement*, and here in the U.S., we are pushing to lead this evolution.

―A Message From Chairman and Chief Executive Officer Roger D. Linquist,” *MetroPCS Annual Report 2011* [emphasis added].

[56] *Prise Declaration*, ¶9.

[57] *Vulcan Comments* at 38.

To the extent that it will be as easy for device manufacturers to move between BC-17 and BC-12 LTE capabilities as Vulcan Wireless claims, wireless carriers with BC-12 networks will be able to benefit from AT&T's purchase volumes with respect to economies of scale in LTE chipset and handset production without the mandate.

38. Indeed, AT&T has stated that, as a general matter, it would be straightforward to create BC-12 variants of handsets created for other, already-deployed LTE bands.[58] However, although it is relatively easy to create BC-12 versions of handsets created for other existing LTE bands, some other variations are more technically challenging than others. For example, AT&T has indicated that creating a CDMA variant of a GSM phone involves more substantial changes, including changes to the antennas and internal layout of the handset.[59] Therefore, an AT&T phone would seem to be a poor choice as the base model for a variant for the A Block carriers because AT&T uses GSM and the A Block carriers primarily use CDMA.[60]

2. Other carriers have successfully obtained LTE handsets.

39. The marketplace evidence is consistent with its being relatively easy to create variants of LTE handsets for existing band classes. For example, the claim that LTE carriers other than AT&T and Verizon Wireless are unable to obtain handsets due to a lack of economies of scale is belied by the fact that such ―small" carriers have already obtained handsets. Currently, Samsung is making its newest, most advanced LTE handset available to Sprint, T-Mobile USA, US Cellular, AT&T, and Verizon Wireless all at roughly the same time. Indeed, the first two carriers to offer the handset in the

58 *Prise Declaration*, ¶15.

59 *Prise Declaration*, ¶¶22-25.

60 *Id.* ¶¶22 and 23.

United States are Sprint and T-Mobile USA, not AT&T and Verizon Wireless, and US Cellular will be offering the handset at the same time as AT&T.[61]

40. The handset, the Samsung Galaxy S III, is —widely considered this summer's blockbuster Android smartphone."[62] It has received many positive reviews. The Washington Post summarized reviews after the phone's European release in May, noting that most reviewers agreed it was —the best Android smartphone on the market" and that —[m]ost also said that the phone could give Apple's iPhone 4S a run for its money."[63] With respect to the United States, *The Wall Street Journal* review agreed that the Galaxy S III is —a very good phone, and a strong competitor for the iPhone and for other leading Android models. In every major feature area, such as voice calling, Web browsing, and photography, it performed very well."[64] The *New York Times* review found that the —Galaxy S III is an amazing, amazing phone – the crème de la Android."[65] Importantly for this proceeding, the handset has —the same design and features" for each carrier.[66] Thus, there is no basis for proponents of the mandate to claim that they are unable to obtain phones comparable to those offered by AT&T and Verizon Wireless.

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61 Chloe Albanesius, —Samsung Galaxy S III Coming to U.S. Cellular This Week," PCMag.com, July 10, 2012, *available at* http://www.pcmag.com/article2/0,2817,2406912,00.asp, site visited July 11, 2012.

62 Michelle Maisto, —Enterprise Mobility: Samsung Galaxy S III: A First, Hands-On Look Before It's Everywhere," eWeek.com, June 20, 2012, *available at* http://www.eweek.com/c/a/Mobile-and-Wireless/Samsung-Galaxy-S-III-A-First-HandsOn-Look-Before-Its-Everywhere-820015/?kc=EWKNLBOE06222012FEA1, site visited June 22, 2012.

63 Hayley Tsukayama, —Samsung Galaxy S III: Review roundup; Samsung's latest wows reviewers in Europe," *Washington Post*, May 29, 2012.

64 Walter Mossberg, —Galaxy Quest: One Phone Aimed At All Networks," *The Wall Street Journal,* June 20, 2012 (hereinafter *WSJ Review*).

65 David Pogue, —A Phone Bristling With Extras," *The New York Times*, June 21, 2012.

66 *WSJ Review*.

41. A variety of smaller U.S. carriers have previously obtained other LTE handsets as well. For example, US Cellular has previously offered (and still offers) another BC-12 LTE handset.[67] Vulcan Wireless claims that this handset has ―severe limitations.”[68] However, the ―limitations” identified by Vulcan Wireless are not related to the handset itself but instead are the result of the fact that US Cellular's LTE network is not available in many areas. Vulcan's error is exemplified by the following quotation from its comments, which attempts to demonstrate the handset's shortcomings:[69]

> In its review of the Samsung Galaxy S Aviator, CNET, the popular technology website, concluded that ―the *carrier's* limited 4G LTE access… weigh[s] down” the *handset*…

42. MetroPCS is another LTE carrier that currently uses a different band class than either AT&T or Verizon Wireless and so, according to proponents' arguments, presumably does not enjoy any economies of scale in obtaining handsets. Furthermore, MetroPCS was the first U.S. wireless carrier to launch its LTE network and the first carrier to offer an LTE handset and so, again, allegedly would not have enjoyed any economies of scale.[70] Nonetheless, MetroPCS has obtained multiple LTE handsets from multiple manufacturers. MetroPCS currently offers four LTE handsets from three manufacturers (LG, Samsung, and Huawei).[71]

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67 *Vulcan Comments* at 20.

68 *Id.*

69 *Id.* [Emphasis added; ellipses in original.]

70 ―A Message From Chairman and Chief Executive Officer Roger D. Linquist,” *MetroPCS Annual Report 2011*.

71 MetroPCS 4G LTE handset listings *available at* www.metropcs.com/metro/category/Phones/4G+LTE/cat170022, site visited June 20, 2012.

43. Despite its presumptive lack of scale, MetroPCS has apparently been able to obtain handsets at prices sufficiently comparable to those paid by AT&T and other wireless carriers to allow MetroPCS to compete. AT&T, Verizon Wireless and other carriers typically offer smartphones at a subsidized rate pursuant to a multi-year contract. By contrast, MetroPCS offers month to month service without a long-term contract.[72] Despite the lack of subsidy from a contract, MetroPCS offers its Huawei LTE handset for $149 and has stated in its Annual Report that it expects to be able to purchase LTE handsets in the second half of 2012 at a price that will allow it to sell them to consumers for less than $150.[73] Verizon Wireless' LTE phones (which are different models) without a contract are offered at $359.99 to $649.99.[74]

B. THE PROPOSED MANDATE IS NOT NEEDED TO ENSURE ROAMING

44. Proponents of the mandate assert that it is necessary to allow roaming. This assertion is incorrect for several reasons:

- First, BC-12 handsets can already roam on other LTE bands in the same way that BC-17 (AT&T) or BC-13 (Verizon Wireless) handsets can. Multiband phones are common and the ability to add bands is becoming cheaper. Thus, the proposed mandate would not enable roaming, but would, at most, save one ―port" with respect to one possible roaming partner.

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72 MetroPCS website ―No Annual Contract" at http://www.metropcs.com/metro/whymetro/payinadvance.jsp, site visited June 22, 2012.

73 MetroPCS 4G LTE handset listings *available at* www.metropcs.com/metro/category/Phones/4G+LTE/cat170022, site visited June 20, 2012; ―A Message From Chairman and Chief Executive Officer Roger D. Linquist," *MetroPCS Annual Report 2011*.

74 Verizon Wireless' website at http://www.verizonwireless.com/b2c/store/controller?item=phoneFirst&action=viewPhoneOverviewByDevice&deviceCategoryId=1, site visited June 27, 2012.

- Second, lower 700 MHz A Block licenses collectively have national coverage, and the licensees could roam on each other's BC-12 networks.

- Finally, a forthcoming LTE feature would facilitate roaming without the likely costs of the proposed mandate.

1. The requirement would save one "port" with respect to one possible roaming partner, but this has limited value.

45. The question with respect to the mandate is not whether lower 700 MHz A Block licensees will be able to roam on other LTE networks. 700 MHz A Block licensees can do so already. There is no technical reason why a carrier operating a BC-12 network could not utilize handsets that could today roam on any other LTE network in the country. The carrier could do so by offering multi-band handsets, which are widely available and used. For example, AT&T's BC-17 LTE handsets already are equipped to roam on Band Class 4 (AWS) and the European GSM 900 and 1800 MHz bands, and future AT&T offerings will be equipped with Band Class 2 (1900 MHz) and Band Class 5 (850 MHz) LTE capabilities as well.[75] Hence, any claim that an interoperability mandate is necessary to allow roaming is incorrect.

46. A multi-band handset able to communicate over Band 4 (AWS) would, for example, have a variety of roaming options. Band 4 (AWS) is likely to be the first LTE Band that will have multiple carriers and national coverage, as Metro PCS, T-Mobile,

75 *Prise Declaration*, ¶26; AT&T website technical specifications for Galaxy Samsung S III indicating that the handset operates on the GSM 900 and 1800 MHz bands, *available at* http://www.att.com/shop/wireless/devices/samsung/galaxy-s-iii-pebble-blue.html, site visited June 26, 2012.

Leap, Verizon Wireless and AT&T are all deploying—or have announced deployments of—LTE in that band.[76]

47. A handset operating on multiple bands typically devotes a “port” to each band.[77] Vulcan Wireless has expressed concern that, as of today, there are limited ports available within certain spectrum ranges and that using separate ports for BC-12 and BC-17 would leave no slot available for using the low-frequency cellular band.[78] Vulcan claims that requiring use of BC-12 by all base stations operating on lower 700 MHz spectrum would mean that a roaming agreement between carriers using lower 700 MHz A, B and C Blocks would not require an additional “port,” or band slot, thus freeing up a port for cellular use.[79]

48. Although there may be some value to using fewer ports for LTE capability so that more ports are available for operation on earlier generation networks or for international roaming, behavior in the industry indicates that it is commercially viable to offer handsets

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76 *AT&T Comments* at 4. Maisie Ramsay, “FCC Denies Delay Request on Verizon AWS Deal,” Wireless Week, July 9, 2012, *available at* http://www.wirelessweek.com/News/2012/07/fcc-denies-delay-request-on-verizon-aws-deal/, site visited July 13, 2012. Lynette Luna, “MetroPCS: $100 LTE handsets will come mid-2012,” FierceBroadbandWireless, October 23, 2011, *available at* http://www.fiercebroadbandwireless.com/story/metropcs-100-lte-handsets-will-come-mid-2012/2011-10-23, site visited July 13, 2012. Phil Goldstein, “T-Mobile to launch LTE in 2013 in AWS spectrum divested from AT&T,” FierceWireless, February 23, 2012, *available at* http://www.fiercewireless.com/story/t-mobile-launch-lte-2013-aws-spectrum-divested-att/2012-02-23, site visited July 13, 2012. Leap press release, “Leap’s Cricket Service Begins Network Transition to 4G LTE with First Commercial Market Launch in Tucson, Arizona,” December 21, 2011, *available at* http://leapwireless.mediaroom.com/index.php?s=13383&item=97670, site visited July 13, 2012.

77 Qualcomm also developed a switchable port where a single port could be switched between two 700 MHz band classes and the 850 MHz cellular band. (*Qualcomm Comments* at 60.)

78 *Vulcan Comments* at 40.

79 *Id.* at 39.

that enable operation on multiple LTE bands. AT&T itself plans to deploy LTE on four different bands, which will require four different ports to allow roaming even within its own LTE network.[80] Announced U.S. LTE deployments currently cover eleven different bands.[81] As a result, the industry recognizes the need for handsets with large numbers of ports and is developing technologies to support them.

49. Indeed, Vulcan's concern has already been addressed by Qualcomm. Qualcomm's new MSM8960 chipset contains an additional port for a sub-1 GHz band (*e.g.*, cellular) and “will provide Lower A block licensees with interoperability with any LTE band (or bands) they wish, subject to the limitations of existing technical solutions and to marketplace capacity issues.”[82] In economic terms, therefore, the opportunity cost of a port is falling as the result of innovation.

50. It should be noted that LTE is also being deployed in bands above 1 GHz. For example, MetroPCS has already deployed LTE service using AWS spectrum (which is above 1 GHz), and T-Mobile, Leap, Verizon Wireless and AT&T have announced such deployments.[83] Lower 700 MHz A Block network operators can have their customers roam on these bands without using up a sub-1-GHz port. Hence, Vulcan's opportunity-cost argument has even less force.

51. The incremental value of saving one port would, in any event, apply only to roaming agreements between lower 700 MHz A Block networks and AT&T's lower 700

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80 Current AT&T handsets allow BC-4 (AWS) and BC-17 (lower 700 MHz B and C). AT&T will later add BC-2 (cellular) and BC-5 (PCS). *AT&T Comments* at 4.

81 *Qualcomm Comments* at 2.

82 *Qualcomm Comments* at 62

83 *Op cit.* 76.

MHz B and C Block network. Such roaming agreements would seem to be relatively unattractive for reasons unrelated to this proceeding. The rest of AT&T's network is based on GSM/UMTS technology, while proponents of the mandate, to the extent they have existing networks, generally use CDMA technology. Thus, until voice over LTE is fully implemented, if a CDMA-based carrier were to roam on AT&T for LTE service, it would still need to roam on a CDMA-based carrier to provide voice service. Hence, CDMA-based carriers would seem to be more natural roaming partners for most lower 700 MHz A Block licensees. Moreover, the lower 700 MHz A Block licensees collectively have national coverage and would be natural roaming partners with one another. Lastly, given proponents' stated concerns with multiple band classes, the fact that AT&T is deploying its LTE network on multiple band classes would again seem to make AT&T a less natural roaming partner than some other carriers.

2. The forthcoming multiple Frequency Band Indicator feature may reduce the number of ports needed to roam without losing the quality advantages of BC-17.

52. Another example of industry efforts to solve the “many-bands” problem is LTE's multiple Frequency Band Indicator (“FBI”) feature. Although this feature has not been finalized, its design reflects ongoing industry efforts to address both interference concerns and interoperability concerns.[84] The current intent is to allow base stations to support multiple bands.[85] One band class would be the “primary” band class, and the specification currently calls for the base stations to be backwards compatible with

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[84] Declaration of David Wolter, attached to *AT&T Comments*, ¶¶16-17.

[85] *Id.,* ¶¶16-17 and note 6. We understand that, since Mr. Wolter filed his declaration, 3GPP has issued some, but not all, of the relevant standards necessary for full implementation of this feature as an enhancement to Release 10 rather than being first introduced in the forthcoming Release 11.

existing handsets using that band class (although, as with all new technologies, manufacturers would have to conduct tests to determine with certainty that equipment implementing the new standard was, in fact, fully backwards compatible). The base stations would also operate a ―secondary" band class (and, potentially, multiple secondary band classes).[86]

53. The multiple FBI feature could, in principle, resolve the A Block carriers' roaming concerns (reducing the need for additional ports) while still allowing BC-17 devices to be used (*i.e.*, a BC-17 network could use BC-17 as its primary band class and continue to serve its existing BC-17 devices, while offering BC-12 as a secondary band class which could be used by new BC-12 devices). The feature is presumably being developed because firms are interested in using it. As a matter of economics, carriers such as AT&T would have an incentive to adopt this feature because it would allow them to integrate A Block spectrum into their networks while still being able to offer their subscribers the quality benefits of BC-17 filtering when utilizing lower 700 MHz Blocks B and C.

54. Note that the fact that technologies like this multiple FBI feature are quickly evolving is another reason to avoid regulatory mandates. Given that the industry is developing technological advances that will provide new options for both roaming and mitigating interference issues, it would be premature to impose a regulatory mandate specifying use of a particular technology (*e.g.,* BC-12).

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86 Existing handsets deployed today using that band class would not be able to operate on the secondary band under the multiple FBI feature.

IV. CONCLUSION

55. Proponents of the BC-17 ban are seeking to use regulation to improve their competitive positions at the expense of distorting competition and harming consumer welfare. Retroactive regulation such as a ban on use of BC-17 can chill investment and is particularly risky given potential interference concerns. There is no need to bear these risks. Lower 700 MHz A Block carriers can obtain LTE handsets and engage in LTE roaming without need for a ban on BC-17 and mandatory use of BC-12. Moreover, the industry is in the process of crafting alternative means of attaining interoperability. The bulk of the costs of the proposed mandate will fall squarely on a single carrier – AT&T – which will have the effect of distorting competition as well as potentially harming consumer welfare, particularly if the interference concerns prove valid.

V. QUALIFICATIONS

A. MARK A. ISRAEL

56. I am Mark A. Israel. I am a Senior Vice President and Managing Director in the Washington, DC office of Compass Lexecon, LLC, an economic consulting firm.

57. From August 2000-June 2006, I served as a full-time member of the faculty at Kellogg School of Management, Northwestern University. I received my Ph.D. in economics from Stanford University in 2001.

58. At Kellogg and Stanford, I taught graduate level courses in business strategy and economics. In my academic research, I specialize in the economics of industrial organization, which is the study of individual markets and includes the study of antitrust and regulatory issues, as well as the economics of information and insurance markets.

My research has been published in leading economics journals including the American Economic Review and the Rand Journal of Economics.

59. I have worked in consulting at Compass Lexecon since 2006, where I have applied theoretical and empirical methods to the analysis of mergers and related antitrust issues, intellectual property, class certification, and damages calculations, in a range of industries including cable television, wireless communications, airlines, consumer products, financial markets, pharmaceuticals, publishing, and various high technology industries.

B. MICHAEL L. KATZ

60. I am Michael L. Katz. I hold the Sarin Chair in Strategy and Leadership at the University of California at Berkeley. I hold a joint appointment in the Haas School of Business Administration and in the Department of Economics. I have also served on the faculty of the Department of Economics at Princeton University and the Stern School of Business at New York University. I received my A.B. from Harvard University *summa cum laude* and my doctorate from Oxford University. Both degrees are in Economics.

61. I specialize in the economics of industrial organization, which includes the study of antitrust and regulatory policies. I regularly teach courses on microeconomics and business strategy. I am the co-author of a microeconomics textbook, and I have published numerous articles in academic journals and books. I have written academic articles on issues regarding the economics of network industries, two-sided markets, systems markets, and antitrust enforcement. I am a co-editor of the *Journal of Economics and Management Strategy* and serve on the editorial boards of *Information Economics and Policy* and the *Journal of Industrial Economics*.

62. In addition to my academic experience, I have consulted on the application of economic analysis to issues of antitrust and regulatory policy. I have served as a consultant to both the U.S. Department of Justice and the Federal Communications Commission on issues of antitrust and regulatory policy. I have served as an expert witness before state and federal courts. I have also provided expert testimony before a state regulatory commission and the U.S. Congress.

63. From January 1994 through January 1996, I served as the Chief Economist of the Federal Communications Commission. I participated in the formulation and analysis of policies toward all industries under Commission jurisdiction. As Chief Economist, I oversaw both qualitative and quantitative policy analyses.

64. From September 2001 through January 2003, I served as the Deputy Assistant Attorney General for Economic Analysis at the U.S. Department of Justice. I directed a staff of approximately fifty economists conducting analyses of economic issues arising in both merger and non-merger enforcement. My title as Deputy Assistant Attorney General notwithstanding, I am not an attorney.

C. ALLAN L. SHAMPINE

65. I, Allan L. Shampine, am a Senior Vice-President of Compass Lexecon. I received a B.S. in Economics and Systems Analysis s*umma cum laude* from Southern Methodist University in 1991, an M.A. in Economics from the University of Chicago in 1993, and a Ph.D. in Economics from the University of Chicago in 1996. I have been with Compass Lexecon (previously Lexecon) since 1996.

66. I specialize in applied microeconomic analysis and have done extensive analysis of network industries, including telecommunications and payment systems. I am the

editor of the book *Down to the Wire: Studies in the Diffusion and Regulation of Telecommunications Technologies,* and I have also published a variety of articles on the economics of telecommunications and network industries. I am an editor of the American Bar Association journal *Antitrust Source*. In addition, I have previously provided economic testimony on telecommunications issues on a variety of matters before the Federal Communications Commission and state public utility commissions.

VERIFICATION PAGE

I hereby swear under penalty of perjury that the foregoing is true and correct.

Mark A. Israel

Dated: July 16, 2012

VERIFICATION PAGE

I hereby swear under penalty of perjury that the foregoing is true and correct.

Michael L. Katz

Dated: July 16, 2012

VERIFICATION PAGE

I hereby swear under penalty of perjury that the foregoing is true and correct.

Allan Shampine

Dated: July 16, 2012

ATTACHMENT C

Before the
Federal Communications Commission
Washington, DC 20054

In the Matter of	)	
	)	
Promoting Interoperability in the 700 MHz Commercial Spectrum	))	WT Docket No. 12-69
	)	
Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band	)))	RM-11592 (Terminated)

REPLY DECLARATION OF MICHAEL PRISE AND JEFFREY HOWARD

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Interoperability of Mobile User Equipment Across Paired Commercial Spectrum Blocks in the 700 MHz Band	)	RM-11592 (Terminated)

REPLY DECLARATION OF MICHAEL PRISE AND JEFFREY HOWARD

I. QUALIFICATIONS AND BACKGROUND.

1. My name is Michael Prise. My title is Distinguished Member of Technical Staff in the Subscriber Product Engineering group at AT&T Labs. I am the same Michael Prise who submitted an initial declaration in support of AT&T's Opening Comments.

2. My name is Jeffrey Howard. I am Vice President – Devices and Accessories at AT&T. In this position, I have responsibility for the selection, procurement and sales of AT&T's wireless device portfolio. I have worked at AT&T since 1996 and have over 15 years of experience in product development. I hold a B.S. in Electrical Engineering from the Georgia Institute of Technology and an M.B.A. from Kennesaw State University.

II. PURPOSE AND SUMMARY

3. The purpose of this Reply Declaration is to respond to incorrect and misleading assertions made by certain proponents of a Commission mandate that would require AT&T to use only Band 12 LTE devices, rather than Band 17 devices.

4. First, we demonstrate that claims made by some A block licensees that they cannot obtain LTE devices comparable to those offered by AT&T and Verizon have been refuted by recent marketplace developments. Samsung, for example, recently announced that its most advanced LTE handset will be simultaneously available to AT&T, Verizon, Sprint, T-Mobile, and U.S. Cellular, and C-Spire has announced that it will also distribute that device when it launches its LTE network later this year. And Huawei, one of the largest mobile equipment suppliers in the world, has publicly stated that it is committed to deliver a complete portfolio of Band 12 devices.

5. Second, we respond to U.S. Cellular's assertion that it experienced unique challenges in obtaining devices to offer with the initial roll out of its Band 12 LTE network. As we explain below, the experience described by U.S. Cellular is actually very similar to AT&T's experience in obtaining devices for its initial LTE deployment. If anything, it appears that when U.S. Cellular first deployed its LTE network, it was able to offer a broader array of LTE devices more quickly than AT&T did when AT&T first deployed its LTE network.

6. Third, we respond to RCA's contention that a Band 12 mandate would benefit A block licensees by allowing them to use (or easily adapt) the same devices that manufacturers make for AT&T. As explained in Mr. Prise's initial declaration, a hypothetical AT&T Band 12 device would use GSM/UMTS technology for voice services everywhere, and for data services in locations where LTE service has not yet been deployed. By contrast, A block providers generally require CDMA technology for voice and fall-back data services. There are significant

differences in the device architecture for these two technologies, including the fact that GSM/UMTS devices use single radio operation for simultaneous voice and data while CDMA devices use dual radio operation. Thus, while a manufacturer can readily replace the LTE components of a non-Band 12 device type with Band 12 components at little or no cost, converting a GSM/UMTS-capable device to a CDMA-capable device would require more substantial changes – which likely explains why early Band 12 devices have been variants of Verizon Band 13 LTE devices that already incorporated CDMA (and dual radio) capabilities.

7. Fourth, we address arguments that a Band 12 mandate is needed to ensure that A block licensees have roaming options. Bands 12 and 17 are just two among numerous bands that will be used by U.S. wireless providers for LTE. Almost all providers will need to provide service over multiple LTE bands to obtain full coverage and the marketplace is meeting that demand with the increased availability of multi-band chipsets. Multi-band chipsets exist today that would allow an A Block provider's customers to roam on LTE networks operating in another band, and Qualcomm will soon be producing chipsets that will support up to 7 different bands, including 3 bands below 1 GHz.

8. Finally, we address Vulcan's suggestion that AT&T can easily convert its existing Band 17 devices to Band 12 with an "over-the-air" software update. No such software exists today, and to the extent such software could be developed, that would have to be done by each of the device and chipset manufactures that have devices deployed in AT&T's network. Even if these manufacturers were able and willing to develop such software, it could not be deployed over-the-air without causing many AT&T devices to lose the capability to connect with AT&T's network. Further, no over-the-air solution is even theoretically possible for the many LTE modules that are embedded in machines of all types. And, in all events, this approach would

impose substantial costs on AT&T and severely limit AT&T's ability to deploy carrier aggregation and other techniques to maximize its efficient use of spectrum.

III. MARKETPLACE REALITIES REFUTE CLAIMS BY A BLOCK LICENSEES THAT THEY CANNOT OBTAIN ACCESS TO THE MOST ADVANCED LTE DEVICES.

9. Certain A block licensees assert that the FCC should require AT&T to use Band 12 LTE devices, because that is the only way to ensure that A Block providers will have access to the latest LTE devices. In his prior declaration, Mr. Prise explained that now that Band 12 has been established, it is relatively straightforward for device manufacturers to make Band 12 "variants" of non-Band 12 devices. Marketplace developments since Mr. Prise's declaration further confirm that the marketplace is responding to the needs of A block licensees and timely providing them with the most advanced LTE devices.

10. U.S. Cellular, the only A block licensees that has actually deployed a Band 12 network, recently announced that it now offers the Samsung Galaxy S III, which is "[t]he new flagship smartphone from the world's number-one mobile phone company"[1] and is regarded by analysts and the industry as among the most advanced LTE handsets available in the marketplace today. David Pogue of the New York Times describes the Galaxy S III as "an amazing, amazing phone — the crème de la Android." Joanna Stern of ABC News describes it as "packed to the brim with cutting-edge mobile technology and new features, making it . . . the Android phone to beat this year."[2] And U.S. Cellular itself describes its new LTE offering as "the next big thing,"

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[1] Sascha Segan, *Samsung Galaxy S III (Sprint)*, PC Magazine (June 20, 2012), *available at* http://www.pcmag.com/article2/0,2817,2406037,00.asp.

[2] Joanna Stern, *Samsung Galaxy S III Review: The New Android Phone to Beat*, ABC News (June 20, 2012), *available at* http://abcnews.go.com/Technology/samsung-galaxy-android-smartphone-review/story?id=16607381#.T-NKarXY_gc.

and "[t]he most anticipated smartphone of the summer"[3] Notably, U.S. Cellular is obtaining the device at the same time as T-Mobile, Sprint, AT&T and Verizon and at a cost that has allowed it to offer the device at price comparable to the price offered by those other providers.[4] And Huawei, one of the world's largest suppliers of mobile telecommunications equipment, has recently been quoted that it is "committed to delivering [A block licensee] United Wireless a complete portfolio of solutions, and will be offering band class 12 devices."[5]

11. In addition to the Samsung Galaxy S III, U.S. Cellular also offers the Samsung Galaxy Aviator handset. It is a variant of the Samsung Droid Charge offered by Verizon, but it includes additional cutting edge new technology. For example, unlike the Verizon Droid Charge, the Galaxy S Aviator is a LTE *quad-band* device – the first of its kind in the U.S. AT&T does not yet offer a quad-band LTE device.

12. C Spire has announced that it too will offer the Galaxy S III when it launches its LTE network later this year.[6] This is particularly notable because C-Spire does not yet have an operational LTE network and is not expected to begin providing service until the fall. We understand that C Spire will among the first wave of U.S. carriers providing LTE service over AWS spectrum. This fact further underscores that manufacturers are willing to make variants of

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[3] U.S. Cellular Website, http://social.uscellular.com.

[4] Lynn Walford, *Samsung Galaxy S III (S3) Review of News/Release Date Roundup*, Wireless and Mobile News (June 11, 2012), *available at* http://wirelessandmobilenews.com/2012/06/samsung-galaxy-iii-s3-review-news-2.html.

[5] Maisie Ramsay, *LTE Interoperability: The Fix Carriers Count On*, Wireless Week (June 1, 2012), *available at* http://www.wirelessweek.com/Articles/2012/06/LTE-Interoperability-the-Fix-Regional-Carriers-Count-On.

[6] C Spire Press Release, *Samsung Galaxy S III Coming Soon On Nation's First Personalized Network* (June 12, 2012), *available at* http://www.cspire.com/company_info/about/news_detail.jsp?entryId=14200004.

cutting edge devices for different LTE band classes, including for companies that do not yet even have any LTE customers.

13. In our view, it is telling that the A block licensees that have already deployed or announced LTE networks are completely silent on the upcoming devices in their own pipelines. AT&T, for example, has several LTE devices in the pipeline that are not exclusive to AT&T, and that will thus presumably be offered by other LTE providers. Moreover, the few LTE handsets that will be exclusive to AT&T are exclusive solely in terms of various aspects of outside appearance. Devices with the same or similar capabilities will likely be available to other providers without those particular aspects of outside appearance.[7]

IV. U.S. CELLULAR FAILS TO SHOW THAT IT HAS FACED UNUSUAL ROADBLOCKS IN OBTAINING QUALITY LTE DEVICES.

14. U.S. Cellular in its comments and accompanying declaration focuses on challenges it faced in obtaining devices to coincide with its initial LTE launch.[8] But U.S. Cellular's experience is not at all unusual, and is very similar to AT&T's experience. In fact, it appears that U.S. Cellular was able to obtain LTE devices faster than AT&T when it first launched its LTE network. This is not surprising as manufacturers were able to build on the work they had already done for AT&T and Verizon to produce Band 12 LTE devices for U.S. Cellular.

15. U.S. Cellular explains that it had to begin working with manufacturers long before its launch of LTE services. According to U.S. Cellular, it began working with manufactures in early 2010 to be able to launch LTE devices in March, 2012. U.S. Cellular's experience is

[7] As one example of such an "exclusive appearance" arrangement, AT&T is the exclusive provider of the HTC 1X. But Sprint offers the HTC EVO 4G LTE, which has similar capabilities, but without particular outside physical characteristics that are exclusive to AT&T.

[8] U.S. Cellular Comments at 4 & Anetsberger Decl. ¶¶ 2-13.

similar to that of AT&T. AT&T began providing manufacturers with technical details of its device requirements in 2008 and, subsequently, provided manufacturers with a detailed roadmap for LTE devices in the summer of 2009. AT&T first deployed data-only devices in its network in August 2011 and smartphones in November 2011.[9]

16. U.S. Cellular next explains that although it initially contacted nine different manufacturers, only two of them were able to have devices ready in time for U.S. Cellular's initial launch. One of those two manufacturers agreed to provide devices on the condition that U.S. Cellular share in the development costs. U.S. Cellular explains that it declined to share in those costs. Accordingly, U.S. Cellular ultimately deployed a suite of devices at its initial LTE launch from one manufacturer (Samsung). Again, U.S. Cellular's experience is not all that different from AT&T's experience. AT&T initially contacted over 10 manufacturers about LTE devices, but ultimately offered devices from only two manufacturers when it launched its LTE network.

17. If anything, U.S. Cellular was able to obtain and offer devices faster than AT&T when it deployed its LTE network. Within weeks of launching its LTE network, U.S. Cellular offered three Samsung devices – a handset, tablet, and mobile hotspot.[10] As noted, AT&T had only data-only devices when it launched its LTE service in August 2011 and did not deploy a LTE handset until a few months later in November 2011.

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[9] AT&T obtained data cards that were LTE-upgradable in the fall of 2010. These devices were not capable of LTE operation until they were upgraded in August 2011.

[10] *See* U.S. Cellular Comments, Anetsberger Decl. ¶¶ 4-10. U.S. Cellular seems to imply without saying so that that it was unable to obtain devices for three weeks after it launched its LTE service. But the reason for this brief delay could also be explained by U.S. Cellular seeking to provide data-only service for some period of time before launching a more complex voice-data service.

18. Since AT&T deployed its LTE network, AT&T has continued to work with manufacturers to expand the number of device manufactures that make devices compatible with AT&T's LTE network. There is likewise no reason that U.S. Cellular will not be able to expand its stable of device suppliers. Nothing in U.S. Cellular's pleadings indicates that manufacturers were unwilling to develop devices for U.S. Cellular. In fact, U.S. Cellular's website indicates that it is working with additional manufacturers to expand its "portfolio of devices."[11]

V. A BAND 12 MANDATE WILL NOT BENEFIT A BLOCK LICENSEES BY ALLOWING THEM TO USE (OR READILY ADAPT) DEVICES MANUFACTURED FOR AT&T.

19. Mr. Prise explained in his initial declaration that even if AT&T were forced to use only Band 12 devices, most A block licensees would not be able use those same devices in their networks modifications. Specifically, to provide data service where LTE has not yet been deployed and to provide voice service, AT&T devices use GSM/UMTS technology. By contrast, most A block operators need CDMA technology to provide data service where LTE service is not available, and to provide voice service. Consequently, an A block licensee seeking to use a hypothetical AT&T Band 12 device would need a variant of the device that replaces the GSM/UMTS components with CDMA components. As Mr. Prise explained, this is not a trivial change, and could require significant changes to the design of the device. It is likely for this reason that the initial devices offered by U.S. Cellular are variants of Verizon devices that were equipped at the outset with dual radio operation CDMA capabilities, and not of AT&T devices that lack those capabilities.

[11] U.S. Cellular Website, http://www.uscellular.com/4G/index.html ("Our network is growing to bring you faster speeds, and so is our portfolio of devices. We are currently working with manufacturers to deliver the best 4G LTE capable devices").

20. Notably, some A block licensees have recognized this point. As one press report recounts:

> But Laskowsky [the wireless network manager at United Wireless], isn't sure the company really stands to benefit from an interoperability mandate. As he explains it, AT&T's band class 12 phones fall back to its legacy GSM network. Because United Wireless is a CDMA provider, it still won't be able to use phones from AT&T's portfolio even if the interoperability mandate passes; it needs phones that are both LTE band class 12 and CDMA, and AT&T's devices under the regulations would be LTE band class 12 and GSM.[12]

21. To the best of our knowledge, the only party to dispute this is a trade association of rural carriers, RCA. In a recent press report, the head of RCA, Steve Berry, asserts that a mandate requiring AT&T to use Band 12 devices "will open up the availability of devices [for A block licensees] – even if they need an extra chip for CDMA fall back."[13] Mr. Berry's comment exhibits a failure to grasp the relevant issue here. As Mr. Prise explained in his initial declaration, CDMA providers would need to add a CDMA radio and ensure that the LTE and CDMA radios were capable of operating simultaneously. For this reason, accommodating the different CDMA components could require design changes to the device. Indeed, in some instances, the GSM/UMTS functionality in an AT&T device is integrated into a chip that provides broader functionality and this entire chipset would need to be replaced. It is thus much simpler to make a Band 12 variant for a CDMA-based carrier based on another CDMA-based device, which is apparently what occurred when Samsung developed the Aviator phone for U.S. Cellular.

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[12] Maisie Ramsay, *LTE Interoperability: The Fix Carriers Count On*, Wireless Week (June 1, 2012), *available at* http://www.wirelessweek.com/Articles/2012/06/LTE-Interoperability-the-Fix-Regional-Carriers-Count-On.

[13] Maisie Ramsay, *LTE Interoperability: The Fix Carriers Count On*, Wireless Week (June 1, 2012), *available at* http://www.wirelessweek.com/Articles/2012/06/LTE-Interoperability-the-Fix-Regional-Carriers-Count-On; *see also* RCA Comments at 18.

22. In any event, Mr. Berry's argument undermines the A block licensees' position that the FCC should require AT&T to use only Band 12 devices. If it were easy and inexpensive to transform an LTE handset using GSM/UMTS for data fallback and for voice to an LTE handset using CDMA for data fallback and for voice, the mandate Mr. Berry is seeking would not be necessary. Under his view of technology, A block carriers could already readily obtain Band 12 variants of AT&T's Band 17 handsets: there is no dispute that the Band 17 LTE components can be changed to Band 12 components during manufacture at little or no cost.[14] Thus, in our view, Mr. Berry's assertions are reasons for the Commission to *reject* a Band 12 mandate, not to adopt one. In all events, as the Samsung Galaxy III release confirms, going forward Band 12 variants are likely to be offered at the outset when a device manufacturer introduces a new cutting edge device platform.

VI. A BAND 12 MANDATE IS NOT NECESSARY TO ENABLE ROAMING.

23. Mr. Prise demonstrated in his initial declaration that a Band 12 mandate is not necessary to enable A block carriers to obtain nationwide data or voice roaming. LTE is already being provided over numerous bands, including not only Bands 12 and 17, but also Band 4, Band 13 and soon Band 5. We understand that ultimately more than 10 bands will be used to provide LTE services. Today, AT&T's LTE devices have both Band 17 and Band 4 capabilities, and when AT&T obtains quad-band LTE devices, those devices will also have Band 2 and Band 5 capabilities. Thus, A block licensees already have numerous roaming options.

24. Given the multi-band LTE environment, chipset makers are working to develop chipsets that give carriers the broadest array of band options possible and that would support a wide variety of roaming options. Qualcomm explains that today it offers chipsets that support

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[14] AT&T Comments, Prise Decl. ¶ 15; Vulcan 12/12/11 *Ex Parte*, WT Docket No. 11-18, Attachment, at 9.

five 2G, 3G, or 4G paths, with two ports that can be used below 1 GHz.[15] This means that even if an A block licensee needs one port to be used to support Band 12 and another for fallback CDMA over Cellular (850 MHz), there remain three ports that can be used to roam on AWS (Band 4) or PCS (Band 2) LTE networks. And, because A block licensees are only at the beginning stages of deploying LTE networks, they have maximum flexibility to choose the bands on which they want to roam and have their phones designed accordingly. In addition, A block licensees can always roam on the networks of other A block licensees. In this regard, A block spectrum is national in scope.

25. Qualcomm's comments further confirm that LTE roaming options for A block licensees will only increase in the near future. Qualcomm explains that it is in the process of releasing commercial samples that contain 7 ports, 3 ports for low band spectrum below 1 GHz, 3 ports for high band spectrum above 1 GHz, and 1 port for very high Band spectrum (2.5 GHz), which will further expand roaming options available for A block licensees.[16] Thus, A block operators will be able to obtain multi-band devices that can roam on AT&T's Band 17 network as well as LTE networks of other providers.

VII. AT&T COULD NOT UPDATE SOFTWARE IN BAND 17 DEVICES TO MAKE THEM COMPATIBLE WITH BAND 12 BASE STATIONS.

26. Vulcan wireless speculates, with no explanation or technical reference, that "legacy Band Class 17 devices could be upgraded to recognize Band Class 12 base stations and channel numbers through a remote software update."[17] Apparently, Vulcan believes that AT&T

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[15] Qualcomm Comments at 60. *See also* RIM Comments at 7-9 (explaining that RIM devices include support for multiple bands).

[16] Qualcomm Comments at 61-62.

[17] Vulcan Comments at 38.

could distribute a software "update" to the millions of existing Band 17 devices "over-the-air" that would enable these Band 17 devices to instead recognize Band 12 signaling.[18] In fact, it is not at all clear that such an over-the-air update is technically or practically feasible. And even if it were, it would unquestionably cause substantial harm to AT&T and its customers.

27. ***Technical Feasibility.*** We are not aware of any existing software that could be installed on existing Band 17 devices that would make them act as Band 12 devices. Nor is it clear that such software could be developed or deployed to the devices over the air as Vulcan suggests. Indeed, we are not aware of any instance where AT&T or any other carrier has altered the Bands in numerous different devices used by millions of customers using over-the-air updates. It is pure speculation on Vulcan's part that such software updates could be created for each Band 17 device on AT&T's network, and that such software could be installed error-free on millions of Band 17 devices over-the-air.

28. In fact, we understand that, for many LTE devices, there is not even the theoretical possibility of developing the hypothesized update. Not all of the devices that utilize AT&T's Band 17 network are produced for and sold by AT&T. For example, as Mr. Prise explained in his previous declaration, AT&T certifies various LTE-compatible modules that third parties then use in their own devices (these devices are referred to by AT&T as "non-stock devices"). These "non-stock" devices include, for example, laptops, tablets, modems, set top boxes and routers. In addition, automobile manufactures are beginning to incorporate these modules into automobiles. To date, AT&T has certified 16 non-stock devices that incorporate modules that permit the devices to connect to AT&T's network and currently has 19 more pending. We have confirmed that these modules are not configured to accept any over-the-air

[18] *Id.*

software updates that would enable them to change the band class used by the module. Thus, if AT&T were to transition to Band 12, these devices would either be made inoperable or would not operate as designed.

29. ***Impediments To Development.*** Even if such a software update were theoretically feasible, there would be several very significant (and potentially insurmountable) practical challenges to developing such software updates. Contrary to Vulcan's suggestion, AT&T is not in a position to develop the necessary update; that would need to be done by the device manufacturers (working in concert with chipset manufacturers). It is our understanding that the Commission cannot force manufacturers to develop such an update, and it is far from clear that they would have incentives to do so. Device manufacturers primary interest is in developing new, innovative handsets not developing software to change the band class of existing phones after-the-fact.

30. Because no such "update" currently exists it would have to be developed anew. Based on discussions with device manufacturers, it is not at all clear that it is technically feasible to develop a software update that could reliably change the band class used by LTE devices via and over-the-air update. Manufactures further emphasize that such an update has a significant potential to render devices unable to connect to AT&T's LTE network or even completely inoperable. This is not surprising as the update would affect the core signaling functionality of the device.

31. But even assuming that manufacturers would be willing to develop such a software update, it would likely take far longer than the "few months" suggested by Vulcan.[19] As Mr. Wolter explained in his initial declaration (¶¶ 35-36), manufacturers must manage limited

[19] Vulcan Comments at 38.

resources, competing demands for their equipment, feature priorities, and other products, and can only focus on a limited number of projects at any given time. The proposed software updates are specialized products and would require substantial involvement of highly experienced engineers and programmers who may not be immediately available. The process is further complicated by the fact that, as explained below, AT&T could not begin deploying any software updates until *all* manufacturers had completed their respective updates. It is also quite likely that the update would require coordination between the finished device manufacturer (*e.g.*, Samsung) and the chipset maker (*e.g.*, Qualcomm), which would further complicate and slow the process.

32. Deployment would further be delayed, because rigorous testing of the software updates would be required. As noted, Vulcan's proposed update would change the signaling mechanisms used by handsets to communicate with base stations, and any problems with such software could render a device non-functional (or at least non-functional for LTE). This testing could easily take several months per software update, depending on how well the software performed in the tests.

33. ***Impediments To Implementation.*** Even after this hypothetical software had been developed and fully tested, there would be insurmountable practical challenges to actually deploying it "over-the-air" as proposed by Vulcan. To ensure that no device loses LTE capability, all of the over-the-air software updates imagined by Vulcan would have to be simultaneously sent to all Band 17 devices, and then AT&T would have to immediately cut over its base stations to work with the newly-minted "Band 12" devices. Failure to update any Band 17 device would mean that it would no longer be capable of connecting to AT&T's now Band 12 LTE network.

34. There are several reasons why this feat could not be accomplished in practice. AT&T does not have sufficient network capacity to push a complex software update to millions of devices simultaneously. AT&T's experience is that over the air updates of only 20 MB, which are far less complicated those proposed by Vulcan, can be pushed out to only about 70,000 subscribers per day. Consequently, it can take weeks to push out an over the air update to all of AT&T's millions of customers. During that time, even to the extent such updates are successful, some AT&T customers would have Band 12 devices and others would have Band 17 devices. However, AT&T's network could support only Band 17 *or* Band 12 devices, thus guaranteeing that myriad AT&T customers would lose LTE connectivity for a significant period of time.

35. Moreover, AT&T's experience with these less complicated over the air updates shows that they have only about a 70 percent success rate. Thus, even if the more complicated updates suggested by Vulcan had similar success rates, substantial numbers of AT&T customers would not obtain the update and would not be able to connect to AT&T's LTE network after AT&T transitioned its network to Band 12.

36. There are many reasons why an over the air update would not succeed. Many devices inevitably will be turned off, others will be outside the area where the update is occurring (*e.g.*, outside the country or roaming), and others will be operating on Wi-Fi. These devices would not receive the over-the-air update. Consequently, there inevitably would be a large number of devices that would still function only on Band 17 after the over-the-air update was launched. Because AT&T can support only Band 12 or Band 17 devices, not both, the devices that failed to receive the update would no longer be LTE-capable after the base station

conversion. And those that did receive the Band 12 update would immediately cease to be LTE-capable *until* the base station conversion was completed.

37. The difficulties in distributing such an update cannot be overstated. Owners of some devices – tablets, for example – often use their devices without accessing the cellular network for weeks or months, and thus would not receive over-the-air software updates. Consequently, when these customers eventually sought to use the LTE network using the device's Band 17 components, they would find that they have been left behind and that their device is not compatible with AT&T's now-Band 12 network. In addition, customers may inadvertently interrupt the update, *e.g.*, by turning off or restarting their handsets, thus interrupting the update and possibly causing their device to become inoperable. To remedy these situations would require *ad hoc* over the air updates or in-store updates, or some combination of the two.

38. ***Operational Issues Created by "Fake" Band 12 devices.*** The software update imagined by Vulcan would create devices with Band 17 filters but that advertise themselves as Band 12 devices. In other words, although these devices would present themselves to networks as Band 12 devices, they would not be capable of operating as true Band 12 devices. For example, they could never operate (or operate properly) over an A block operator's network, because these devices would still contain Band 17 filters that attenuate transmissions in the frequencies used by A block spectrum. In this regard, these devices would not comply with 3GPP specifications for Band 12 devices.

39. If AT&T were required to attempt to create these "fake" Band 12 devices, that would limit AT&T's ability to incorporate A block spectrum into its network in the future in the event existing interference issues are resolved. These "fake" Band 12 devices would advertise

themselves as being able to send and receive transmissions over A block but, in fact, would not be able to do so. These problems would only multiply once AT&T implements carrier aggregation techniques (part of LTE Advanced). Carrier aggregation allows the simultaneous allocation of resources across multiple spectrum bands, thus providing much more efficient use of scarce spectral resources. For example, in a carrier aggregation scenario, a device operating in Band 2 (1900 MHz) and that advertises Band 12 capability can be allocated resources in the A block but may not be able to receive/transmit calls if it has Band 17 filters and does not fully support all of Band 12.

40. ***Significant Harm To AT&T.*** Even if all of these practical difficulties could be overcome, Vulcan's proposal would cause significant harm to AT&T and its customers. First, it is highly unlikely that device and component manufactures would develop any software updates needed to convert Band 17 devices to Band 12 devices for free. AT&T would thus be forced pay for those updates. Such custom software development can be very costly, and here those costs are multiplied by the number of different manufacturers from which AT&T would need updates.

41. Second, given that the proposed update would make fundamental changes to core signaling functionality, AT&T would also need to incur very substantial testing costs. AT&T could not transmit software updates to customer devices without first conducting extensive testing to make sure that (1) such updates could be effectively transmitted over-the-air-update and (2) that the software would work as intended.

42. Third, AT&T would likely incur significant loss of good will, and potentially loss of customers. As explained above, there is no way that such a software update could be transmitted simultaneously to every customer in a particular market. As a result, there would inevitably be large numbers of customers who would find that their LTE handsets no longer

operated as expected, and who would require individualized attention to update their devices with the appropriate software, either over the air or in an AT&T store. In addition, no amount of careful planning and testing can eliminate the real risk that for some devices the update will not function properly. This is not, as Vulcan claims, a "minor" feature update,[20] but a major change in the air interface that presents a real risk of introducing error/failure that would impact the devices operation. These problems are multiplied by the fact the complex software update would be done "over the air" for millions of devices. In these circumstances, there almost certainly would be a sizeable number of phones that do not properly download the software update (or where the software update simply does not work due to an unanticipated problem). Most customers are not likely to understand that they lost LTE connectivity – presumably the reason they purchased the LTE device – as a result of FCC mandates, but would instead blame AT&T.

[20] Vulcan Comments at 38.

VERIFICATION PAGE

I hereby swear under penalty of perjury that the foregoing is true and correct.

/s/ Michael Prise____________
Michael Prise

Dated: July 16, 2012

VERIFICATION PAGE

I hereby swear under penalty of perjury that the foregoing is true and correct.

/s/ Jeffrey Howard
Jeffrey Howard

Dated: July 16, 2012